SILURIAN STROMATOPOROIDS OF AMERICA

(EXCLUSIVE OF NIAGARA AND GUELPH)

BY

WILLIAM ARTHUR PARKS, Ph.D.

ASSOCIATE PROFESSOR OF GEOLOGY
UNIVERSITY OF TORONTO

PREFATORY NOTE

The present paper forms the third of a series of articles on the Stromatoporoids of America. The first and the second contributions are known respectively as No. 4 and No. 5 of the Geological Series of University of Toronto Studies. The above papers deal with the forms from the Guelph and Niagara formations. The present article is divided into three parts. Part I contains a description of the Helderbergian forms. Part II treats of the examples from the Silurian area around Hudson Bay, which must be regarded as of about the same horizon as the Niagara. Part III deals with certain Niagara forms which have come to the notice of the author since the appearance of *Niagara Stromatoporoids*. It is hoped, therefore, that the three pamphlets now issued will together include all the forms known from the Silurian of America.

Whatever merit this work may possess is, in large part, due to the kindness of the gentlemen who have afforded me an opportunity of studying the material in their collections. To the following palaeontologists, and to the institutions which they represent, I therefore wish to express my most sincere thanks:—

Dr. J. F. Whiteaves and Dr. H. M. Ami, Geological Survey of Canada.

Dr. J. M. Clarke, State Geologist, State of New York.

Dr. Charles Schuchert, Yale University.

Dr. Ray S. Bassler, United States National Museum, Washington.

Dr. F. A. Bather, South Kensington Museum, London.

Dr. E. O. Hovey, American Museum of Natural History, New York.

Mr. T. E. Savage, Illinois State Geological Survey.

In addition to the literature already referred to in the introduction to *Niagara Stromatoporoids*, mention must be made of the excellent description of Helderbergian Stromatoporoids, by

Dr. George Herbert Girty, in the second volume of the 48th Report of the Regents of the New York State Museum, 1894. The only other original description of a Helderbergian form is contained in ***Stromatoporidae of the Upper Silurian***, by Dr. J. W. Spencer. (Bull. Mus. University of Missouri, 1882.) The literature bearing on the forms from Hudson Bay has already been listed, with the exception of a short preliminary article by myself in the 22nd volume of the *Ottawa Naturalist*, 1908.

SILURIAN STROMATOPOROIDS OF AMERICA

I. HELDERBERGIAN STROMATOPOROIDS

The Helderbergian rocks of the State of New York furnish a most interesting series of "Milleporoid" Stromatoporoids, which are closely related to one another and to certain forms belonging to the coralline limestone of the Niagara. In many of these specimens the ultimate fibre is excellently preserved, and yet the gradation from one form to another is so imperceptible that some doubt may be expressed as to their specific differentiation. While it has been thought advisable to retain all the forms previously described, it must be admitted that new species could be easily created which would stand on as firm a foundation as some of those herein included. The variation of structure in different parts of the coenosteum of the same specimen is so great that care must be exercised in creating new species lest the multiplication of forms results in making none of the species determinable.

The most important feature revealed by the study of these forms is with regard to the minute structure of the fibre. Students of the Stromatoporoids will recall the work of Baron von Rosen, *Ueber die Natur der Stromatoporen*, in which the affinities of the group to the sponges is strongly maintained. Plate I, figure 2, of that work exhibits a vertical section of *Stromatopora typica*, in which the ultimate fibres of the skeletal matter are arranged in horizontal and vertical rows so that a rectangular network results. Von Rosen interprets these elements as sponge spicules. Dr. Nicholson, in his description of *Actinostroma astroites** refers to this plate, but he interprets the appearance as being due "to a sort of decomposition, in conse-

*British Stromatoporoids, p. 128.

quence of which the thick and reticulated skeleton-fibre becomes broken up into innumerable minute, dark-coloured, vertical and horizontal lines." Precisely the appearance represented in Von Rosen's figure is shown by examples of *Stromatopora constellata* from the coralline limestone of New York; it is also to be observed in *Syringostroma ristigouchense* from Cap Bon Ami, and it is presented in greater or less perfection by all the examples from the Helderbergian of New York. It is impossible to believe, in the face of this evidence, that such a widespread structure is the result of mineralization.

In the species *Actinostroma astroites*, Rosen *sp.*, we have, according to Nicholson, an example of the genus in which the radial pillars occur to the number of twelve or fifteen in the space of one mm. Nicholson comments on the similarity of this structure to that of the minute fibre of *Stromatopora typica*, but, as above stated, he believes that the resemblance is only accidental and due to the alteration of the latter species. In this connection it is interesting to record the discovery of a similar species growing beneath a colony of *Stromatopora constellata*. The radial pillars are as numerous as 24 to the mm. With their connecting arms, they build up a rectangular network of exactly the same size of mesh as the overlying *Stromatopora constellata*; in fact, *the cœnosteum is exactly the same as that of the latter species, but without the astrorhizal and vertical canals.* We have therefore two facts established beyond question,—first, the existence of a rectangular arrangement of fibre in a large number of Stromatoporoids; second, the occurrence of precisely similar fibre without the vertical and horizontal can[illegible] If this latter form is the skeleton of a colony of zooids, eac[illegible] individual must have been less than the 24th of a mm. in diameter. Such extreme tenuity is hardly to be imagined in the case of any Coelenterate. The genus *Stromatopora*, at least as far as the present examples are concerned, is evidently nothing more than an extremely fine *Actinostroma* pierced by numerous vertical tubules—the so-called zooidal tubes.

The above considerations and many other facts which have recently come under my observation tend strongly away from Nicholson's conclusions as to the Hydrozoan affinities of the

Stromatoporoids. If the position taken above with regard to the relation of *Actinostr. ma* to *Stromatopora* can be more fully established by further evi. nce, the: the two divisions of "Milleporoid" and "Hydractinoid" types must be abandoned as the main basis of classification. Nicholson's argume · in support of the Hydrozoan character of Stromatoporoids res.s largely on the interpretation of the horizontal partitions in the vertical tubes as "tubulae." I am convinced that, in some cases at least, these partitions result from the continuation of horizontal strands of skeletal fibre across the pore. I do not, h vever, consider that enough evidence has yet been obtained to justify such a sweeping change in the method of classific tion as must result from a complete proof of the principles suggested above.

ORDER—STROMATOPO IDEA, *Nicholson and Murie*

Section A. ("Hydractinoid" Group)

Family—ACTINOSTROMIDAE, *Nich.*

Genus—CLATHRODICTYON, *Nich. and Murie.*

CLATHRODICTYON JEWETTI *Girty*—Plate X : Figs. 1 and 2.

CLATHRODICTYON JEWETTI, *Girty*, Rep. Mus. State of New York, 48th, vol. ii, p. 308, pl. vi, figs. 5 and 6, 1895.

Dr. Girty's description is as follows:—"Coenosteum known only as a small fragment. Latilaminate, possibly massive. Surface characters not known. Laminae very conspicuous in vertical section. Radial pillars persistent thr ugh one interlaminar space, usually terminating in the laminar partition. Tangential sections show the cut ends of the radial pillars, which are apparently not connected by arm-like processes, but by a continuous wall. Monticules are present associated with astrorhizae and axial tubes, but the character of the astrorhizae has not been determined. The skeleton does not show the 'pillar and arm' structure characteristic of *Actinostroma*, nor the reticulated skeleton common in *Syringostroma*.

"The species resembles *C. striatellum*, Nicholson, in many particulars, but the latter is without astrorhizae, monticules, etc.,

which form a striking feature in the *Actinostromidae*. It differs from Nicholson's species also in the more normal pillars and regular mesh. All the sections studied have been cut from a small fragment which alone represents the species. In none of them do the radial pillars extend through a number of interlaminar spaces, and although an apparent prolongation through two or even three such spaces may occasionally be observed, the occurrence is too rare to influence the generic determination of the specimen."

To this description there is little to add. I have prepared two sections which are here produced (Plate XVI, figs. 1 and 2). The astrorhizal systems are very inconspicuous, and there is no direct evidence as to the ultimate structure of the skeletal matter. It has an indistinct granular appearance, but is very much mineralized. There is no sign of the double-based pillars characteristic of *C. striatellum*, and the fibre is coarser than in that species. The spacing of the laminae is very like that of the form described by myself as *C. rectum* from the Niagara of Louisville, Ky., but the pillars are not so strictly vertical and are less regular in their development.

Locality—Lower Pentamerus limestone, Cedarville, N.Y. The type specimen is in the Peabody Museum, Yale University.

Section B. ("Milleporoid" Group)

Family—STROMATOPORIDAE, *Nich.*

Genus—SYRINGOSTROMA, *Nicholson.*

In view of Dr. Girty's objections to the generic relations of certain species, it seems necessary to define the genus *Syringostroma* somewhat more closely than has hitherto been done. There can be no doubt that Nicholson's general conception of the genus was that of a "Milleporoid" type, in which the reticulated tissue is aggregated into distinct vertical pillars, connected at intervals by laminae. The genus *Actinostroma*, on the other hand, consists of individual vertical fibres, or dense pillars, connected by laminae, which arise as whorls of arms developed from the pillars. The essential difference is, therefore, that the pillars of *Syringostroma* are reticulate and those of *Actinostroma* are

not. As already pointed out, the skeleton-fibre of certain species of *Stromatopora* is precisely the same as that of a fine-grained *Actinostroma*. It may be said, therefore, that *Syringostroma* is a sort of compound *Actinostroma*—a *Stromatopora* in which the vertical canals are so arranged that they leave round pillars of tissue between them, thus simulating the structure of *Actinostroma*. It is obvious, therefore, that transitions will naturally occur between *Syringostroma* and *Stromatopora*. In fact, the whole series of forms described by Dr. Girty are intermediate in character. They all show the pillar-like structure in vertical section, but in tangential section it is less pronounced. Could this appearance not be revealed at all, it would be necessary to remove the whole series from the genus. Thin sections, however, show more or less distinctly the severed ends of these pillars, but in one species at least so indistinctly that it seems better to remove the form to the genus *Stromatopora*. Bearing in mind that the pillars and laminae are merely parts of the same general tissue, we have two variables—the thickness of the laminae and their distance apart. If the laminae are thin, far apart, and connected by round pillars, we have a typical *Syringostroma*. On the other hand, if they are thick and close together, so as to be separated by the ramifications of the astrorhizal canals only, we have a typical *Stromatopora*. The following species are described by Dr. Girty, who ascribes them all to *Syringostroma* —*S. centrotum*, *S. consimile*, *S. microporum*, *S. barretti*, and *S. foveolatum*. In the order named they show less and less of the typical *Syringostroma* structure and approach more and more to the *Stromatopora* type. I propose to remove the last-named species to the latter genus, but it must be admitted that the dividing line is difficult to draw. Of Dr. Girty's species I find three easily distinguishable types—*S. centrotum*, *S. foveolatum*, and a type of which *S. consimile* is the most important representative. The practical distinction of *S. consimile*, *S. barretti*, and *S. microporum* I find to be a matter of great difficulty and of doubtful value.

SYRINGOSTROMA RISTIGOUCHENSE, *Spencer, sp.*—Plate XVI, Figs. 3, 4, and 5.

COENOSTROMA RISTIGOUCHENSE, *Spencer*, Bull. Mus. Univ. State of Missouri, p. 49, pl. vi, figs. 12 and 12a, 1884.
SYRINGOSTROMA RISTIGOUCHENSE, *Nicholson*, Mon. Brit. Strom., p. 97, pl. xi, figs. 11 and 12, 1886.
SYRINGOSTROMA RISTIGOUCHENSE, *Nicholson*, Ann. and Mag. Nat. Hist., April, p. 324, pl. viii, figs. 6-8, 1891.
ACTINOSTROMA RISTIGOUCHENSE, *Girty*, Rep. State. Mus., N. Y., 48th, vol. ii, p. 298.
SYRINGOSTROMA RISTIGOUCHENSE, *Whiteaves*, Can. Rec. Science, p. 138, 1896.

Dr. Nicholson's description is as follows: "The coenosteum in this species is massive, more or less definitely latilaminar in growth, and readily splitting into thick strata concentric with the surface. The laminae are gently curved, and there are either no astrorhizal eminences (mamelons) or but very inconspicuous ones. Astrorhizae are, as a rule, very well developed, being of large size and much branched. They are arranged in vertically superimposed systems, and have their centres about one cm. apart.

"Vertical sections [Pl. XVI, figs. 3 and 4] show the skeleton to be composed of thick, close-set, parallel, radial pillars, which are minutely porous in structure. The radial pillars are separated by narrow zooidal tubes, about five or six pillars occupying a space of 2 mm., measured transversely, while about seven 'concentric laminae' occupy the same space, measured vertically. Tangential sections [Pl. XVI, fig. 5] show the large, rounded ends of the transversely divided radial pillars, placed close together, and united in a stellate manner by whorls of delicate radiating connecting processes or 'arms.' The rounded or sinuous pores included within the hexactinellid network thus formed represent the zooidal tubes as seen in section. In the fact that the coenosteum consists of well developed radial pillars, united at corresponding levels by whorls of connecting processes, *Syringostroma ristigouchense* resembles an *Actinostroma*, while in the minutely porous structure of the skeleton-fibre it entirely resembles a typical *Stromatopora*."

The fibre of this species is not so well preserved as in many examples of *Syringostroma* and *Stromatopora* from the State of New York, nevertheless its reticulate character is sufficiently shown in the better parts of many sections. The vertical fibres are quite well marked, and the horizontal reticulation is apparent

in transverse section. The horizontal fibres, however, do not maintain a direction at right angles to the vertical with the same degree of persistency exhibited by some of the New York species. In some places, however, as viewed in vertical section, sufficient proof is obtainable that the square network is the basis of structure, although a more irregular network is produced by the flexures of the horizontal fibres. The figure shown (Pl. XVI, fig. 4) is considerably restored, and it represents the appearance above described in a more striking manner than has really been seen over a section of such extent. It will be observed that the gross horizontal laminae are in some cases quite thick, and not formed of a single whorl of fibres, as must be the case in an example of the genus *Actinostroma*. The continuity of the radial pillars is also a function of the thickness of the section: in very thick slices they are strongly marked and continuous for considerable distances, but in very thin sections this appearance is entirely lost, in consequence of the fact that the astrorhizal canals invade the sides of the pillars so as to give them the appearance of being entirely interrupted at intervals. Dr. Nicholson considers the round or angular pores which appear where the tangential section follows a lamina to be the severed ends of zooidal tubes, and he considers the vertical interspaces observed in vertical section as being the longitudinal sections of the same structures. Now, where the tangential section follows an interlaminar space the severed pillars are surrounded by a completely open annulus, which is always in free communication with the astrorhizal canals. What, then, has become of the zooidal tubes? Either they are non-existent or their walls, on two sides at least, were composed of soft tissue. In either event, it is manifestly wrong to interpret the vertical interlaminar spaces as zooidal tubes. Doubtless *pores* pierced the laminae between the pillars and passed into the interlaminar spaces, but it is not in accord with the facts to state that these pores represent the habitation cavities of zooids.

Locality.—Helderbergian, Dalhousie, Cap Bon Ami, New Brunswick.

SYRINGOSTROMA CENTROTUM, *Girty*.—Plate XVI, Figs. 6, 7, 8, and 9, and Plate XVIII, Figs. 6 and 11.

SYRINGOSTROMA CENTROTUM, *Girty*, Report, State Museum, New York, 48th, vol. II, p. 293, pl. VIII, figs. 1 and 2, 1894

Dr. Girty's description is as follows: "Coenosteum massive, spheroidal, often attaining a large size. Intermittent concentric growth results in the formation of latilaminae, which are usually conspicuous. The surface is thickly covered with rounded eminences or mamelons, and astrorhizae are numerous but minute. The presence or absence of an epitheca has not been ascertained.

"No specimens in this collection are entire, but all evidence points to an originally spheroidal form for the coenosteum. One specimen appears to have had a diameter of about 27 cm. when entire. The concentric character of the structure is usually quite striking. Some specimens are readily separated into thin sheets or latilaminae. . . . Tangential sections do not remain parallel to the surface in this species, except over small areas, for the curvature is not regular, but flexuous, and the latilaminae are more or less foliaceous and imbricating. Thus extended sections cut the monticules at all angles, and appear like panels of curly maple.

"In specimens which break along the latilaminae the surface is seen to be vermiculate and porous, thickly covered with prominent conical elevations. This characteristic vermiculate structure is shown also in tangential sections, and is not due to weathering and preservation. Astrorhizae are numerous, but small and inconspicuous, as if they were merely the usual porous structure intensified. They are distributed over the surface, and are often to be found on the sides of the monticules. The monticules, as shown by radial section, are usually superimposed throughout one latilamina, but in two successive latilaminae this may or may not be the case. They are often pierced by straight central canals, directed radially. These canals often extend through one whole set of monticules. They have no proper walls, and, therefore, cannot be referred to 'Caunopora' tubes or tubiculous annelids. When broken transversely, the mamelons are seen to be distinctly porous. The pores, or canals, are often arranged in concentric series, coincident with the cut edges of

the intersected laminae, and evidently represent sections of the astrorhizal canals.

"Weathered fractures and properly oriented sections show that the radial pillars are strong, parallel, and continuous through several layers of the coenosteum. They are united at more or less regular intervals by concentric partitions, which have the porous structure above described. These concentric laminae appear to be composed of inosculating fibres, forming a reticulate skeleton, and not of lateral arms given off in a whorl around each pillar, as in the genus *Actinostroma*. Vertical sections through a monticule show that the radial pillars are not parallel as elsewhere, but are inclined at a slight angle away from the imaginary axis of the monticule."

In vertical section (Pl. XVI, figs. 6 and 7) the features so well described by Dr. Girty are clearly shown. Both the horizontal and vertical elements are flexuous and fairly continuous across the slide; of the former about seven occupy the space of 1 mm., while the latter are much more widely spaced, averaging about three to the mm. This wide spacing of the laminae and their extreme thinness (usually only one strand of fibre) constitute the chief means of distinguishing this form from its allies, as seen in vertical section.

Tangential sections (Pl. XVI, figs. 8 and 9) are very characteristic. The close-set astrorhizal systems on raised mamelons give a series of concentric rings and radial canals where severed, strongly suggestive of "curly maple," as stated by the author of the species. The cut ends of the radial pillars are more apparent than in the other species referred to *Syringostroma* by Girty. As the pillars, like the rest of the coenosteum, are composed of a reticulation of fibres, the interspaces between which are only a little less than the diameter of the pillars themselves, it cannot be expected that the cross sections of the pillars should present a strictly round appearance.

The skeletal fibre is not as well preserved in this species as in some of the others. In vertical section (Pl. XVIII, fig. 11) the horizontal components are not well defined; the vertical fibres are more distinct and heavier, frequently forming the borders of the pillars. The general square mesh of the reticulation is indistinctly shown. Tangential sections of the fibre (Pl.

XVIII, fig. 6) also show the greater strength of the vertical elements, the cut ends appearing as distinct dots. The horizontal connecting arms are not so clearly shown, and were doubtless of a more delicate character. The highly magnified tangential section, presenting the appearance described above, is quite characteristic of the species.

Locality. — Helderbergian, Cedarville, N.Y.; Herkimer County, N.Y. The illustrations are prepared from sections No. 1756 and No. 1757, New York State Museum, Albany, N.Y.

SYRINGOSTROMA CONSIMILE, *Girty*.—Plate XVI, Figs. 10, 11, and 12, and Plate XVIII, Fig. 14.

SYRINGOSTROMA CONSIMILE, *Girty*, Rep. State Mus., N. Y., 48th, vol. ii, p. 297, pl. vii, figs. 3 and 4, 1895

With regard to the general shape of the coenosteum, Dr. Girty states: "Coenosteum massive, large and sub-spherical. Latilaminate structure shown by sections or on weathered surfaces. The laminae are disposed in pointed, wave-like folds, which are not superimposed. Skeleton-fibre, finely porous; tissue, reticulate; astrorhizae, few and very large, sometimes provided with a tubular axis."

The whole coenosteum is composed of exceedingly delicate vertical and horizontal fibres, about twenty-five of which appear in the distance of 1 mm. This constitutes the reticulate skeleton-fibre of the organism. Passing through this tissue are vertical interspaces, about eight of which appear in the space of 1 mm. Astrorhizal systems are present, the horizontal canals of which are confluent with these interspaces; but whether or not the ramifications of the astrorhizal canals communicate with all the interspaces, it is impossible to state. Nevertheless, I am inclined to believe that such is the case.

The vertical spaces are interrupted at certain levels by horizontal laminae, which may consist of several meshes of the ultimate network or may be reduced to a single fibre. The thicker laminae are fairly horizontal, and may occur to the number of seven in a mm. The finer ones are more distant, and are apt to turn up into the pointed folds referred to by Dr. Girty. This feature is presented by parts only of the coenosteum, and therefore cannot be considered as of diagnostic value.

The astrorhizae appear to be about 8 mm. apart; they do not usually possess an axial tube, and their horizontal canals are considerably wider than those of *S. constellata*.

Vertical sections (Pl. XVI, figs. 10 and 12) show a reasonable amount of constancy as far as the vertical interspaces and pillars are concerned, from eight to ten of each appearing in the space of a mm. These interspaces are enlarged where they are confluent with the astrorhizal canals. Each "pillar" is fairly continuous, and in some cases is seen to show a dark line on each side, which is produced by the vertical fibre of the reticulation. Much less constancy is exhibited by the gross horizontal elements —the laminae. In the lower part of the figure they are seen to be thick and continuous; in the upper part they are thin and bent upwards into pointed loops. In certain parts of the plate, where the preservation is particularly good, the rectangular meshwork of the skeletal fibre can be distinctly discerned.

Tangential sections (Pl. XVI, fig. 2) show the wide horizontal canals of the astrorhizae and the vermiform skeletal matter. The distinction between laminae and the interlaminar spaces is not well marked, owing to the thickness and contiguity of the laminae. In very thin sections the cut ends of pillars in the interlaminar spaces are more apparent; certain of the vermiform patches resolve themselves into rows of partially coalesced dots. Even on the low scale of magnification of this figure the fibrous, reticulate character of the ultimate fibre can be distinctly seen.

High magnification shows that the skeleton is composed of vertical and horizontal fibres, arranged precisely as in the genus *Actinostroma*. This ultimate structure is common to all the Helderbergian Stromatoporidae, and is seen in species from other formations as well. With regard to the size of the mesh, the present species is intermediate between *Stromatopora foveolata*, in which there are 30 strands to the mm., and *Stromatopora constellata*, in which from 22 to 24 occur in the same space. The fibre is beautifully preserved in the type specimen; a very fortunate section is shown in Plate XVIII, fig. 14. Here the cut ends of the vertical fibres are excellently revealed, and also the fine horizontal connecting elements. Only occasionally is this minute structure shown to such perfection. Usually the angularity of the mesh and the identity of the pillars are lost by mineralization.

Stromatopora constellata, on the one hand, and *Syringostroma centrotum*, on the other, present two extremes, by comparison with which these Helderbergian forms are best determined. The present species differs from *S. constellata* in finer arrangement of the vertical elements, and in the fact that these vertical elements are strictly *interlaminar*. Despite the general resemblance, it must be remembered that this distinction is of generic importance. Tangential sections may be readily distinguished by the wider astrorhizal canals of the present species. From *Syringostroma centrotum* it may be distinguished by the lack of the "curly maple" effect in tangential section, and by the more closely set and thicker laminae. The upturning of the laminae into pointed folds does not seem to be a constant feature. The cross sections of the pillars are less distinct than in *S. centrotum*, because the laminae are closer together and because there is a tendency for the pillars to unite into vermiform rows. The species is much further removed from a typical *Syringostroma* than is *S. centrotum*

Locality.—Helderbergian, State of New York. The type is from the outlet of Skaneateles Lake, and is in the Peabody Museum, Yale.

SYRINGOSTROMA BARRETTI, *Girty*—Plate XVII, Figs. 1 and 2, and Plate XVIII, Fig. 5.

SYRINGOSTROMA BARRETTI, *Girty*, Rep State Mus. New York, 48th, vol. ii, p 296, pl. vii, figs. 5 and 6, 1895

The type specimen of this species I have been unable to obtain, but two examples from the New York State Museum appear to belong to the species, and on them the following description is based. Before attempting this description it will be necessary to give Girty's account in full, as follows:—"Coenosteum large, hemispherical, spreading. Latilaminae distinct, more or less labyrinthine towards the centre, on the periphery flowing in broad folds. They end abruptly on the under side and are attached directly without an epitheca. Laminae parallel and gently flexuous. Astrorhizae not numerous, but large and conspicuous. The nucleus of an astrorhizal system is sometimes represented by an axial tube, and the laminae at that point are

often elevated into a low menticule. Skeletal tissue finely fibrous, but a little coarser than in *S. centrotum*.

"This species is characterized by the infundibuliform, concentric growth and the flat base witho ' an epitheca (?). Without the aid of thin sections, the outer surface of the type specimen appears dense, fine-grained, and structureless, except for latilaminae, which separate in unusually thin sheets. Sections near the surface are without monticules, astrorhizae and axial tubes, exhibiting only the uniform porous skeleton and fibrous structure. The same surface characters are presented by the basal portions and suggest an epithecate condition, but it has not the polished surface and concentric wrinkles characteristic of the epitheca in *Favosites*. Lower Pentamerus, Indian Ladder, New York."

Vertical sections of the examples in my possession which come nearest to the description given above (Plate XVII, Fig. 2), show that the laminae are bent into folds, but this feature is not altogether absent in *S. consimile*, and is therefore not diagnostic. However, a more irregular manner of growth is shown by the greater difficulty in cutting sections which are either strictly horizontal or vertical over any considerable area. The vertical pillars are somewhat heavier than *S. consimile* and are farther apart, only four or five occurring in a mm., whereas seven or eight appear in *S. consimile*. The horizontal laminae are of about the same average thickness as in the other species, but they are somewhat more irregular. In the middle of the photograph the rectangular reticulation of the skeletal matter can be distinctly seen.

Tangential sections (Plate XVII, fig. 1) show that some of the astrorhizae have an axial canal and that the horizontal channels are much ramified. Dark bands representing the severed laminae are more conspicuous than in *S. consimile*, but this appearance is dependent on the thickness of the section. The severed ends of the pillars can be seen in certain parts of the section as well as their tendency to unite into vermiform rows. It is doubtless this tendency that makes these structures so much more apparent in vertical than in tangential section.

The skeletal fibre (Plate XVIII, fig. 5) presents, in tangen-

tial section, a mesh of about the same size as that of *S. consimile*. The fibre itself appears to be somewhat heavier, and distinct dots representing the ends of the vertical elements are not to be seen. These features as well as the rounded shape of the meshes are probably due to a less perfect state of preservation

Dr. Girty himself expresses doubt as to the advisability of separating this species from *S. consimile*. I regret that I have not seen the type of *S. barretti*, for I have doubt as to the identity of my specimens; they do not, in all particulars, agree with Girty's description or figures. The pillars are more continuous, but sections which are not quite vertical are almost exactly like the figure given by Girty. I cannot agree with that author that the two species may be distinguished by the character of the laminae which in *S. consimile* "are angular and independent in their flexures," and in *S. barretti* "gently curved, proximate and parallel." The statement is true for the latter species, but I have not observed the angular inflections as a constant feature in the former. The most practical way of distinguishing the forms is by the larger size and wider spacing of the pillars. The curved laminae are also a means of identification as far as the type specimens are concerned, but I have never found that the exact manner of growth of the coenosteum as a whole is of determinative value.

Like *S. consimile*, this form differs from *Stromatopora constellata* in the thinner and more widely separated laminae. The tangential sections are remarkably alike, but *S. constellata* is built on a much coarser scale, both with regard to the minute fibre and in the gross reticulation. The tangential section of *S. barretti* is much finer than one would expect from an examination of the vertical section. *S. barretti*, in its vertical section, approaches closer to *S. centrotum* than does *S. consimile*; however, it may be distinguished from the former species by the lack of the "curly maple" effect and by the much stronger Stromatopora-like appearance.

Locality.- Lower Pentamerus, Indian Ladder, N.Y. The present figures are prepared from specimens from Clarksville, N.Y. (Section No. 736, New York State Museum.)

SYRINGOSTROMA MICROPORUM *Girty*. Pl. XXVII, Figs. 3 and 4.

SYRINGOSTROMA MICROPORUM Girty, Rep. State Geol. New York, 1894 [illegible]

Dr. Girty's description is as follows: "Coenosteum massive, latilaminate, shape unknown, probably spherical or subspherical. Surfaces parted along the laminae are covered with numerous monticules, which are, however, of small size. They are usually pierced by axial tubes and provided with well developed astrorhizae, seldom visible on the lamellar partings. In vertical section the skeleton is seen to be composed of persistent radial pillars and the customary concentric laminae. Tangential sections show the laminae to have a finely porous structure, the skeletal fibre being of the characteristic reticulated tissue common to other Helderberg Syringostromas. Tangential sections through the monticules show only the cut ends of the astrorhizae. When the section lies on the lateral slope of a monticule, the latter is seen to be provided with an extensively spreading astrorhizal system."

This species approaches so close to *S. consimile* that it would be better to consider it as a variety only. The preservation of the type specimen is not nearly so good as in the case of the latter species, and I am inclined to think that this is responsible for the difference shown by Girty's figures of the two species. In all these fine-grained forms the thickness of the section is so important that wonderfully different results may be obtained. However, the type specimens show some differences and the description of the present form is best expressed in terms of those differences. *S. microporum* has very small monticules placed three or four mm. apart: *S. consimile* has astrorhizal systems the same distance apart, but monticules are absent. I have long been of the opinion that the presence or absence of small monticules is not a feature of specific value. The spacing of the pillars is the same in both species and the laminae are likewise separated by a similar interval. The upturning of the laminae into points in *S. consimile* is by no means universal and cannot therefore be used to distinguish it from the present species. Extended vertical sections of *S. microporum*, in spite of the presence of the monticules, do not show continuous axial

tubes in the astrorhizal centres to as great an extent as similar sections of *S. consimile.* The upturning of the laminae on approaching the axial tubes is also much more pronounced in *S. consimile.* This is the most evident difference between the two species. The skeletal fibre is less well preserved in the type of *S. microporum,* but shows the same rectangular network as the other type. I believe the two to be practically identical, but I should not be justified in destroying an author's species without having had an opportunity to examine more material.

Locality.—Lower Pentamerus limestone, Cedarville, N.Y. The type specimen is in the Peabody Museum, Yale University.

Genus—STROMATOPORA, *Goldfuss*

STROMATOPORA FOVEOLATA, *Girty, sp.*—Plate XVII, Figs. 5, 6 and 7, Plate XVIII, Figs. 4 and 10.

STROMATOSTROMA FOVEOLATUM, *Girty,* Rep. State Museum, New York, 48th, vol. ii, p. 295, pl. vi, figs. 8 and 9, 1895.

Dr. Girty's description is as follows:—"Coenosteum massive and of large size. Outer surface and point of attachment not known. Division into latilaminae usually apparent. In one specimen the latilaminae are folded into regular hemispherical elevations, having a diameter of about 50 mm. Radial pillars continuous and usually large. Viewed in vertical section, the laminae are thick and the interlaminar spaces narrow. Tangential sections show the laminae to have a comparatively dense structure, but the organism may still be referred to the Milleporoid type. The pores, which in *S. centrotum* appear as transparent vermiculate patches, in this species are represented only by minute spots, sometimes connected by transparent thread-like bands. The skeleton fibres are large, with fine reticulations, giving the tissue as a whole a dense consistency. The concentric laminae, likewise, are usually thick and heavy, the vacuoles of small size, and the intercolumnar spaces minute. Astrorhizae are frequent, and well developed monticules appear to be present, chiefly associated with astrorhizae. They are indicated in the section by a darker shading, but their elevation is so slight that tangential sections often show the astrorhizae equally well on all sides. The monticules sometimes have tubular axes.

When weathered, the coenosteum often develops little pits or conical depressions about four mm. apart, which are rather characteristic of the species." To this excellent description there is nothing to be added as far as the gross anatomy is concerned, but it must be pointed out that the skeletal fibre is essentially the same as in *Syringostroma consimile*, consisting of delicate vertical fibres connected by horizontal ones, giving rise in vertical section to a rectangular mesh and in horizontal section to an irregular network. The fibres are somewhat heavier than in *S. consimile*, and, especially in horizontal section, build a finer network.

Vertical sections (Plate XVII, figs. 5 and 6) show very pronounced differences from the species of *Syringostroma* already described. In the latter the pillars occupy the space between more or less continuous laminae; in this species the pillars lie between open bands which represent the planes over which the systems of astrorhizal canals are thrown. The bands of pillars are therefore *laminar*, while in the other species they are *interlaminar* in position. The spaces between the pillars, while they open into the astrorhizal passages, are not coincident with them; they are true pores passing through the laminae, and the "pillars" are not true pillars at all, but vertical sections of the tissue of the *laminae* lying between the open tubes. This constitutes the difference between *Syringostroma* and *Stromatopora*, and it is for this reason that the species is removed to the latter genus. While the gross horizontal elements vary in thickness, an average of four occur in the space of one mm. They are separated by much thinner open bands, representing the horizontal pores. A lamina of average thickness consists of four or five bands of ultimate fibres. These fibres are more or less continuous across the pores, forming the so-called "zooidal tabulae" —an interpretation that I am not inclined to accept.

Tangential sections (Plate XVII, fig 7) show the true Stromatopora type of structure—wide-spreading astrorhizal canals and the dense severed laminae pierced by pores.

The microscopic character of the fibre is beautifully shown in this species; the horizontal and vertical arrangement is distinct in spite of the extreme fineness of the reticulation. Measured

either horizontally or vertically as many as 30 strands to the mm. can be seen. As the fibre itself is somewhat heavy a dense appearance is presented under low magnification. Under higher powers, vertical sections (Plate XVIII, fig. 10) show both horizontal and vertical fibres and the square network. Tangential sections (Plate XVIII, fig. 4) present an irregular network which is much finer than that shown by any other figure on the plate.

This species is even more typically a *Stromatopora* than is *S. constellata*, which we have adopted as a standard for comparison. The pores piercing the laminae are more regular and more distinctly *pores*. About eight of them occur in one mm., and they are separated by interspaces much wider than themselves. The gross vertical elements, if they ever existed, are so interrupted by the astrorhizal canals as to be indistinguishable. In this species the astrorhizae are about 3 mm. apart; in *S. constellata* they may be distant from one another as much as 7 mm.

From *Syringostroma centrotum* the distinction is easily made by means of the thick, closely set laminae and the dense, uniform appearance of the tangential section, which shows no indication of severed pillars or concentric rings.

Locality. Lower Pentamerus, Cedarville, N.Y. Dr. Girty's types are in the Peabody Museum, Yale. The figures here produced are prepared from sections No. 1733 and No. 1736, New York State Museum, Albany, N.Y. No. 2270, Am. Mus. Nat. Hist. is probably the same species, but the general structure is a little coarser. Cherry Valley, N.Y.

Stromatopora coralliфera, *sp. nov.* Plate XVII, Figs. 8 and 9, Plate XVIII, Fig. 7.

Stromatopora concentrica, *Hall and Whitfield* MSS. (Am. Mus. Nat. Hist. Labels.)

The coenosteum in this species has a habit of growth between cylindrical and hemispherical, i.e., the laminae arch strongly upward and as the growth is more rapid in the centre, a cylindrical form results. The type specimen is about 10 cm. high by 8 wide. The cylinders are sometimes conjugate and invested by laminae common to the whole mass.

The most important feature in the minute structure of the

skeleton is the very slight differentiation of the laminae as distinct structures. Nevertheless the concentric manner of growth is clearly shown. The fibrous, reticulate structure of the ultimate skeleton is pronounced. This fibre is pierced by numerous vertical pores of which about six occur in one mm. Between these pores the skeleton-fibre appears as vertical columns when viewed in section, the column being of greater diameter than the pore itself. The horizontal fibres of the general tissues are continued across the pores to the number of 15 or more in a vertical distance of one mm. (zooidal tabulae?). In the true Stromatoporas the definition of the gross laminae depends on the development of layers of horizontal canals; in this species these canals seem to be extremely variable, sometimes no farther apart than the horizontal fibres of the general tissue, sometimes at much greater intervals. The whole effect is to obliterate the concentric laminae unless the delicate lines occurring to the number of 15 in one mm. are to be interpreted as such. The astrorhizae are very large with exceedingly long and tortuous horizontal canals.

Vertical sections (Plate XVII, fig. 8) suggest the genus *Syringostroma* in the long pillar-like portions between the vertical pores; the defined laminae of that genus are, however, wanting. The continuity of the vertical elements is extremely variable, in some places they are cut off by horizontal canals at minute intervals and in others they continue across many strands of the ultimate fibre. That they are not pillars, but interspaces between pores, is seen by the fact that the two margins of an individual are not parallel, but each conforms to the curving of the pore which borders it. The frequent lateral coalescence of the "pillars" also proves that they are not individual elements. Gross laminae which result from the arrangement of the astrorhizal systems at regular intervals are very ill defined. The general concentric manner of growth is, however, clearly seen in the horizontal elements of the skeletal fibre. As in *S. foveolata*, these are partially continuous across the pores, especially if the section is thick. If these fine horizontal lines are interpreted as zooidal tabulae, then there is no trace of horizontal elements in some parts of the coenosteum.

The cut ends of the large astrorhizal canals can occasionally be seen, but the horizontal canals are more commonly represented by depressed openings between the fine laminae.

Tangential sections (Plate XVII, fig. 9) show the extremely well developed astrorhizal systems, with much ramified horizontal canals, the somewhat irregular pores piercing the laminae, and the general Stromatopora-like aspect of the tissue.

The ultimate fibre has the same arrangement as in the other species; it is a little coarser than in *S. foveolata* and a little finer than in *Syringostroma consimile* (Plate XVIII, fig. 7).

The above description is founded on sections which represent the average appearance of the tissue. A great deal of variation is, however, presented by different portions of the same coenosteum—possibly as great a difference as exists between forms herein ascribed to different species. From *S. constellata* the present species differs in its finer ultimate fibre, the more extended astrorhizae and the much less distinct gross horizontal laminae. From *S. foveolata* it may be distinguished by the thinness and variability of the laminae. The astrorhizal systems are not superimposed as they are in *S. foveolata*, and there is no upturning of the laminae towards axial astrorhizal tubes as in that species.

Locality.—Helderbergian, Port Jervis, N.Y. Type specimen No. $\frac{2270}{4}$, Am. Mus. Nat. Hist., N.Y. Probably the same is No. $\frac{2270}{2}$ of the same museum, Perry County, Penn.

II. SILURIAN STROMATOPOROIDS FROM HUDSON BAY.

ORDER—STROMATOPOROIDEA, *Nich. and Murie*
Section A ("Hydractinoid Group")

Family—ACTINOSTROMIDAE, *Nich.*
Genus—ACTINOSTROMA, *Nich. and Murie.*

ACTINOSTROMA TENUIFILATUM, *Parks.*

For description, see *Niagara Stromatoporoids*, page 10.

It is with some hesitation that specimens from Southampton Island are ascribed to this species. The coenosteum is large and hemispherical, readily exfoliating, and presenting low, ill defined and irregularly distributed monticules on the parted surfaces.

The skeletal fibre is exceedingly delicate and much altered by crystallization. About six concentric laminae appear in 1 mm., measured vertically. These elements are thin, but are much more sharply defined than the radial pillars. With regard to the nature of these latter structures considerable doubt must be expressed. They are very badly defined in all the examples, and appear as continuous lines only exceptionally. Without the comparison of a number of sections one would pronounce the organism a *Clathrodictyon*, near to *C. vesiculosum minutum*. The better preserved portions, however, when cut very accurately in a vertical direction, show the continuity of at least some of the pillars.

Locality.—Southampton Island, Hudson Bay, Canada.

ACTINOSTROMA TENUIFILATUM *var.* INFLECTUM, *Parks.*
Plate XIX, Figs. 1 and 2.

ACTINOSTROMA INFLECTUM, *Parks.* Ottaw[illegible] t vol xxii, p. 27, 1898

"While fragments only are avail[illegible]e, the inference is obvious that the coenosteum is of a hemispherical shape, and that it reaches considerable dimensions.

"Vertical sections (Plate XIX, fig. 1) show it to be composed of delicate horizontal elements, the spacing of which is extremely variable, as many as ten or as few as three laminae

occurring in the space of 1 mm. The concentric layers are connected by continuous radial pillars, which occur to the number of six or seven in a mm. Instead of maintaining a horizontal direction, the laminae are bent sharply upwards at intervals of about 1 mm. As each overlying lamina follows the same course, and as the identity of the lamina is lost at the apex of the fold, the coenosteum appears to be traversed by vertical columns made up of loose vesicular tissue. These columns do not show the compact structure of those of Nicholson's *Stylodictyon*, but the general appearance in vertical section is very suggestive of that genus. A similar arrangement is not uncommon in different Stromatoporoids, and it is very questionable whether it is a feature of generic or even specific value. These inflected portions doubtless enclose astrorhizal systems, but horizontal canals are not perceptible. Owing to the upturning of the laminae it is difficult to prepare sections which follow the course of the pillars over any considerable extent. In consequence, one may easily mistake this species for a *Clathrodictyon*.

"Tangential sections (Plate XIX, fig. 2) do not reveal any astrorhizal canals, nor is the preservation sufficiently good to show the whorls of connecting arms typical of the genus. Nothing is presented by such sections beyond the cut ends of the pillars and the obliquely severed upturned edges of the laminae. Typical examples are easily distinguished from *A. tenuifilatum*, but intermediate forms connect the two species, so that one is tempted to regard the examples under discussion as representing a variety only of the latter species."

To the above description there is nothing to be added. A careful study of the significance of inflected laminae has convinced me that no specific value can be attached to that peculiarity. I have, therefore, reduced the species to the rank of a variety.

Locality. — Pagwachuan River, Station 641, and near mouth; Little Current River, 17 miles from mouth. Type collected by Mr. W. J. Wilson, and stored in the Museum of the Geological Survey, Canada.

ACTINOSTROMA TENUIFILATUM *var.* CYLINDRICUM, *var. nov.*

The mode of growth of the coenosteum is distinctly cyl-

drical, each cylinder being about 15 mm. in diameter, and attaining a length of 8 or 10 cm. The cylinders may remain separate or they may coalesce into a conjugate mass surrounded by laminae of the common coenosteum. This cylindrical manner of growth is by no means confined to the present species, but is seen in many others, and will be referred to again in the course of this article.

The laminae are wound around a central axis, and they likewise cover the end of the axis as a series of superimposed, deeply convex caps. Each cylinder therefore grows upwards as well as by increase in diameter.

The minute structure of the fibre is [illegible] with that of *Actinostroma tenuifilatum*. The laminae are more closely set in the initial layers of each cylinder and increase in width of spacing towards the periphery. On the average, six occur in a distance of 1 mm. The radial pillars are continuous and a little more closely set than the laminae. The only difference from the type of the species is seen in the cylindrical manner of growth.

Locality. — Silurian, Southampton Island, Hudson Bay. Type specimen in Museum of Geological Survey, Canada.

ACTINOSTROMA FRANKLINENSE, *sp. nov.*—Plate XIX. Figs. 3 and 4.

CLATHRODICTYON FRANKLINENSE, *Ami*, MSS. Geol. Surv. Canada, Cruise of the Neptune, p. [illegible].

ACTINOSTROMA INTERTEXTUM, *Nich.*, Mon. Brit. Strom., p. 138, pl. XII, figs. 8-11, 1892.

The shape of the coenosteum cannot be stated, as the species is known from a small fragment only. However, it was probably of an explanate character, growing over the substratum and reaching a thickness of at least 15 mm.

The most striking feature in the minute structure of the organism is the sharply defined continuous radial pillars which occur to the number of six in a distance of 1 mm. The horizontal laminae are somewhat more closely set, but they are much less continuous and defined structures. Astrorhizae have not been observed.

Vertical sections (Plate XIX, fig. 3) show the sharply defined continuous radial pillars and the discontinuous, more irregular laminae.

Tangential sections (Pl. ? fig. 4) exhibit the cut ends of the pronounced pillars as round dots. Where the section follows a lamina the dots are connected by irregular lines. The whorls of arms, characteristic of the genus, cannot be observed.

This species can be distinguished by the very sharp definition of the radial pillars and the irregular character of the laminae. The form is remarkably like *Actinostroma intertextum*, Nich., from the Wenlock of England. In fact, it is possibly identical. The only differences are the slightly finer structure and the lack of distinct whorls of connecting arms. It is readily admitted that this latter feature may be due to mineralization, in which case the species are identical.

Locality.—Silurian, Beechy Island, Lancaster Sound, Canada. Type specimen in Museum of Geological Survey, Canada. Name proposed by Dr. H. M. Ami in the *Cruise of the Neptune*. I have listed the species as new because Dr. Ami has, as far as I am aware, issued no description or figures.

Genus—CLATHRODICTYON, *Nich. and Murie.*

A large number of forms belonging to this genus occur in the rocks of Silurian age around Hudson Bay and Davis Strait. It is possible, but highly inadvisable, to create numerous new species, for, although minute differences from known species may be detected, it is not difficult to account for those differences as mere local variations.

CLATHRODICTYON STRIATELLUM, *d'Orb.*

For synonomy and description, see *Guelph Stromatoporoids*, page 14, and *Niagara Stromatoporoids*, page 25.

Several specimens from Southampton Island are probably referable to this species. The horizontal laminae are well defined, but the vertical elements are very indistinct. So much are they destroyed that it is impossible to make statements as to their minute character. The spacing of the laminae is somewhat finer than in typical examples of *S. striatellum* and coarser than in *C. vesiculosum minutum*.

CLATHRODICTYON VESICULOSUM, *Nich. and Murie.*

For synonomy, etc., see *Niagara Stromatoporoids*, page 14.

This species is common, and presents some peculiarities of growth, as the coenosteum is quite variable in form—sometimes hemispherical, sometimes explanate, and occasionally forming cylinders or ramose branches, a habit common to different species in this area. The fineness of the fibre is also variable, as many as 15 fibres to a mm. occurring in some examples. To the localities mentioned in *Niagara Stromatoporoids* must be added Southampton Island, Hudson Bay. British Museum specimen No. P2270 from Cape Riley, N. Devon, is an extremely fine-grained example with unusually large astrorhizal canals. To this species may also be referred certain specimens, in a poor state of preservation, from Griffith Island, Grinnell Land, and Bessels Bay, Greenland.

CLATHRODICTYON VESICULOSUM MINUTUM, *Parks.*

For description, see *Niagara Stromatoporoids*, page 19
Locality.—Southampton Island, Hudson Bay

CLATHRODICTYON CYSTOSUM, *Parks*

For description, see *Niagara Stromatoporoids*, page 21.

A form closely allied to or identical with that type of this species in which the laminae are but little inflected occurs on Southampton Island. The coenosteum forms large hemispherical masses encrusting *Favosites.*

British Museum specimen No. P6993 from Bessels Bay, Greenland, probably belongs to this species

CLATHRODICTYON CYSTOSUM LINEATUM, *Parks.*—Plate XX, Fig. 9.

For description, see *Niagara Stromatoporoids*, page 14.

This variety is represented by large masses on Beechy Island, Lancaster Sound. Some slight differences from the type are observable but a comparison of the figures will show that these are not of specific or even varietal value. Several specimens in the Geological Survey of Canada collection and British Museum specimen No. 56702.

CLATHRODICTYON CYSTOSUM *var.* CYLINDRICUM, *var. nov.*

The coenosteum in the type specimen is about 8 cm. in width

and 6 cm. high. The basal portion is lost. The whole mass consists of conjugate upright cylinders, fifteen of which occur in the type. These structures have an average diameter of 15 mm., and they project at the top of the coenosteum as prominent rounded points. The surface is smooth, or minutely pitted.

The minute arrangement of the skeletal fibre is so like that of *Clathrodictyon cystosum* that it is impossible to remove the form from that species. The cylindrical manner of growth is, however, characteristic, and on that alone the new variety is founded.

The arrangement of the coenosteum into conjugate cylinders is a feature common to several species and to different genera. It indicates a manner of growth only, and cannot be considered of specific value. An insensible transition can be observed between typical Clathrodictyons exhibiting this peculiar manner of growth and the genus *Cyclodictyon*, in which the general fibre is traversed by radiating secondary pillars

Locality.—Silurian, Southampton Island, Hudson Bay, Canada. Type specimen in Museum of Geological Survey, Canada.

CLATHRODICTYON DRUMMONDENSE, *Parks.*—Plate XX
Figs. 7 and 8.

For description, see *Niagara Stromatoporoids*, page 26

Two specimens from Southampton Island represent this species. They have a globose shape, and they are about 50 mm. in diameter. The surface is characteristically rough. The two vertical sections shown in the plate indicate the variation to be seen in a single coenosteum. Figure 7 is from a section cut in a vertical direction through a well preserved part of the skeleton. Figure 8 exhibits the variable aspect of sections, not quite vertical, passing through altered parts of the coenosteum

ACTINODICTYON, *gen. nov.**

The coenosteum is composed of horizontal laminae after the type of such forms as *Clathrodictyon vesiculosum*, i. e., forms in which the vertical pillars are formed by inflections of the laminae.

*For this generic name I am indebted to Professor W. S. Milner, of the University of Toronto. (*ακτίς-ακτινος* and *δίκτυον*.)

The general fibre does not, therefore, differ from that of *Clathrodictyon.* It is, however, pierced by large, spongy pillars at more or less regular intervals. These pillars are quite analogous to those of *Labechia*, but, instead of traversing a tissue of vesicular cells, they pass through the tissue of what is otherwise an ordinary *Clathrodictyon.* In all the species known the laminae are disposed in a concentric manner around an axis, giving rise to a cylindrical form of coenosteum. These cylinders, if single, may produce a ramose form, and, if conjugate, an irregular mass, in which the individual cylinders are apparent only as botryoidal elevations on the surface. The manner of growth has never appealed to me as being of generic or even of specific importance. The new genus, therefore, must rest on the peculiarity of the secondary pillars. It differs from *Stylodictyon*, in that the pillars are not formed by the upward inflection of the laminae and that the tissue is not reticulate. It is interesting to note that as the pillars become more numerous the ordinary elements of the tissue decrease in importance, and eventually become so attenuated that they might be interpreted as zooidal tabulae. I am convinced that the structures resembling tabulae in the species about to be described are to be interpreted as the residuum of horizontal laminae. The genus presents certain strong resemblances to the family *Idiostromidae*, and particularly to *Idiostroma* itself. This resemblance is seen in the cylindrical manner of growth and in the presence of a large open tube in the axis of some of the cylinders. The specimens are too small to justify an opinion as to the character of these tubes; they may be analogous to the tubes of *Idiostroma* or they may be enclosed corals. These structures, however, are not always present. They do not open to the surface, and they do not send out branches into the general tissue of the coenosteum. The resemblance to *Idiostroma* is best seen in the species to be described as *Actinodictyon lowi.* Here the uniform development of large pillars and the attenuation of the horizontal elements makes the similarity very marked. The fibre, however, is not porous, but dense, and there is no evidence of secondary large canals radiating from the axial tube to the surface.

ACTINODICTYON CANADENSE, *sp. nov.*—Plate XX, Figs. 1 and 2.

The coenosteum is known from a small fragment only, and although some observations might be made as to its form, it seems advisable to await the discovery of more material.

The laminae are arranged in a concentric manner around a centre, which in the type specimen is occupied by a coral or axial tube. These elements are extremely variable and much crumpled, their upward inflections giving rise to vermiculate ridges and points which are continued upwards as the vertical pillars of the general reticulation. The spacing of the laminae is also quite variable, as many as six or as few as three appearing in a vertical distance of one mm. Passing through this general fibre are stouter continuous pillars disposed at intervals which vary from ½ up to 3 or 4 mm. These pillars are of greater diameter than the general fibre and appear to be of less dense character, as they disappear with greater rapidity as a section is reduced in thickness.

Vertical sections (Plate XX, fig. 1) show the much crumpled character of the laminae with their upwardly inflected points bearing the pillars, which may or may not reach the lamina next above. The large secondary pillars are conspicuous. A close examination of extended sections seems to indicate that these large pillars first appear as continuations through several interlaminar spaces of the ordinary vertical elements. When, however, the pillar has acquired strength, it passes with a considerable degree of independence through the general tissue.

Tangential sections (Plate XX, fig. 2) vary much with the thickness of the section; the one figured is fairly thick and consequently all the elements are heavier than in a thinner preparation. The cut ends of the pillars (small) are occasionally seen as distinct dots; more usually, however, the dots are replaced by crescentic bands representing the severed edges of the up-turned laminae. In this respect the section is very suggestive of *Clathrodictyon fastigiatum* and its allies. Where the section follows a lamina a very characteristic feature is seen in the large round pores which pass through the lamina. At first I was inclined to regard these pores as analogous to those exhibited by *Stromatoporella*, and to regard the large pillars as tubes. By

comparison with the other species of the genus and by the close examination of several sections, I am convinced that such an interpretation is impossible. The cut ends of the larger pillars are not conspicuous, but can occasionally be made out. This lack of definition is doubtless owing to the less dense character of these structures.

This species is the most Clathrodictyon-like of the four to be described; it represents the lowest stage in the development of the genus.

Locality.—Silurian, Southampton Island, Canada. Type specimen in Museum of Geol. Sur., Can.

ACTINODICTYON LOWI, *sp. nov.*—Plate XX, Figs. 3 and 4.

This species also is known from a small fragment only. The coenosteum presents the same concentric arrangement of its constituent parts as the previous species. Like that species also the elements are disposed around a coralline branch or large axial canal.

The horizontal elements of the coenosteum are very delicate and closely set, as many as fifteen occurring in the space of one mm. They are inflected upwards, but the continuation of the flexures into distinct pillars cannot be made out. The horizontal course of these elements is so interrupted by the much larger secondary pillars that their continuity can scarcely be discerned. The large pillars occur to the number of four in the distance of one mm.; they are irregular in their course, unite with one another and are not always round in cross section.

Vertical sections (Plate XX, fig. 3) are difficult to prepare in a direction following any considerable number of pillars. The figure is drawn from a vertical longitudinal section and in consequence the radiating character of the pillars is not shown. The delicate horizontal elements are much disrupted in places, but are to be observed in parts of the section where no large pillars occur. The irregularity of these latter elements, their coalescence and their greater frequency distinguish this species from *A. canadense*.

Tangential sections (Plate XX, fig. 4) show the cut ends of the pillars, their union either by approximation or by the aid

of the laminae and the tendency to irregular form. As in the case of *A. canadense*, the round pores passing through the laminae are a conspicuous feature

The strong resemblance between the cross section of *A. lowi* and the similar section of *A. canadense* is very striking. The vertical sections, however, are so different that no confusion can possibly result. If I had the present species alone, it is very probable that greater hesitation would be shown in the interpretation of the delicate horizontal elements. Their resemblance to the zooidal tabulae so often referred to cannot be denied, but I hold this interpretation to be quite impossible in view of the resemblance between the two species. The entirely analogous structures in *A. canadense* are undoubtedly the horizontal components typical of the Clathrodictyons. As the supposed Hydrozoan affinities of the Stromatoporoids rest on the interpretation of these structures as tabulae, it is obvious that some doubt is cast on that interpretation by the facts stated above.

Location.—Silurian, Southampton Island, Canada. Type specimen in Museum of Geol. Sur., Can. Species named after Dr. A. P. Low, Deputy Minister of Mines, Canada, by whom the specimen was collected

ACTINODICTYON NEPTUNI, *sp. nov.*—Plate XX, Figs. 5 and 6.

The coenosteum consists of the cylindrical masses characteristic of the genus, some of the cylinders being as much as 30 mm. in diameter. In the type specimen several of these structures are grouped together without any apparent regularity.

The structure of the coenosteum is very like that of *A. canadense*, but the centres of the cylinders are not occupied by corals or axial tubes. The laminae are of the same type as those of *A. canadense;* they are, however, a little more closely set and are not so distinctly inflected upwards into points. The large pillars are arranged in rows along the length of the cylinders, being about 8 mm. apart both horizontally and vertically.

Vertical sections (Plate XX, fig. 5) show the radiating pillars traversing the general reticulation of Clathrodictyon-like fibre.

Tangential sections (Plate XX, fig. 6) exhibit the cut ends

of the minor pillars less distinctly and the ends of the large pillars more distinctly than in *A. canadense*. The round openings so characteristic of tangential sections of the genus are also to be seen.

It will be observed that the differences between the two species are only of slight importance possibly not of specific value at all. It is quite possible that *A. canadense* and *A. neptuni* may be proved to be specifically identical by the discovery of intermediate forms.

Locality.—Silurian, Southampton Island, Canada. Type specimen in Museum of Geol. Sur., Can. Named after the ship *Neptune*, in which the specimens were brought from the north by Dr. Low.

ACTINODICTYON KEELEI *sp. nov.*—Plate XIX, Figs. 5 and 6.

The coenosteum in this species is most distinctly cylindrical and is represented by two fragments, one from a branch 45 mm. in diameter, and the other from a branch of 20 mm. diameter. The surface presents a pitted aspect and exhibits astrorhizae about 15 mm. apart.

The concentric laminae are much more distinct than in the other species of the genus. An average of six appear in one mm. and they are connected by fairly distinct vertical pillars. The formation of these pillars by upward flexures of the laminae is apparent, but to a less degree than in the other species. The large pillars are evidently formed by the occasional continuation of the minor pillars through several laminae.

Vertical sections (Plate XIX, fig. 6) show the fibre to be coarse, but this is perhaps due to mineralization, as certain parts of sections have a much finer appearance. The continuous pillars are irregularly disposed and are evidently composed of superimposed minor pillars. The cut ends of the large canals of the astrorhizal canals are conspicuous.

Tangential sections (Plate XIX, fig. 5) show the cut pillars, the vermiform severed laminae, and the round pores characteristic of the genus. A large astrorhizal canal is seen crossing the section. The figure is considerably restored, as the state of preservation of the specimen is far from good.

This form is very closely related to an ordinary *Clathrodictyon;* it differs only in the concentric arrangement of the laminae and in the superposition of certain pillars. I am convinced, however, that this feature is not merely accidental, as the continuity is much too extended to be so explained. It differs from *Actinostroma* in that these long pillars are only occasionally developed and in the very different aspect of the transverse section. Although the generic features of *Actinodictyon* are less distinctly shown than in the other examples here described, I am inclined to regard the form as closely allied to those from Hudson Bay.

Location. Gravel River, Mackenzie District, Canada. Type specimen in Museum of Geol. Sur., Canada. Named after Mr. Joseph Keele, of the Geological Survey of Canada, by whom the specimens were collected.

Section B. ("Milleporoid" Group)

Family STROMATOPORIDAE, *Nich.*

Genus STROMATOPORA, *Goldfuss*

STROMATOPORA AMII, *sp. nov.* Plate XIX, Figs. 7 and 8.

The coenosteum of this species forms large hemispheric masses 15 cm. in diameter by 10 cm. in height. The point of attachment is not shown, but it was probably of much less diameter than the adult coenosteum. Instead of being formed of the ordinary concentric laminae, the skeleton consists of a series of coalesced tapering cylinders. Each cylinder is, however, composed of the ordinary elements. The laminae are strongly arched upwards and are continuous over the tops of the cylinders, so that these structures grow upwards as well as outwards. This cylindrical manner of growth is common to many Stromatoporoids and is nothing more than a strong expression of the same tendency that leads to the formation of "mamelons." The upper ends of the cylinders appear on the surface as distinct rounded eminences situated from 10 to 15 mm. apart. The whole exterior surface is composed of a fine irregular network of vermiform ridges. Distinct astrorhizae appear to be present, but are not well defined.

The most conspicuous elements in the fibre are the vertical pillars, which, although very irregular, appear to the number of three in the space of one mm. The horizontal laminae are spaced a little wider than the pillars and are even more irregular in their development. These vertical elements are not to be considered as pillars in the strict sense of the word; they are seldom round, but appear to be the downward continuation into the coenosteum of the vermiculate ridges observed on the surface. The laminae are separated by the large canals of the astrorhizae and are pierced by well defined, round pores. Very conspicuous are the arched "tabulae" crossing the intercolumnar spaces and also appearing in the astrorhizal canals. There is no trace of the characteristic reticulated fibre of the genus *Stromatopora*. The coalescence of vertical and horizontal elements is, however, perfect, and the absence of the typical fibre may be the result of mineralization.

Vertical sections (Plate XIX, fig. 8) show the rather pronounced pillars only in part of the plate, probably because at this point the vermiculate ridges are cut at right angles to their direction. A much more common appearance is that presented by the rest of the section. The thick, irregular and interrupted laminae are even less conspicuous than the pillars. The arcuate "tabulae" are distinct; they may be observed crossing the vertical interspaces and also in the horizontal canals. In some sections these structures present many peculiarities, curving into circles, coalescing with each other, and even simulating the vesicular arrangement characteristic of the fundamental fibre of *Stromatocerium*. While not prepared to state that these structures are not true zooidal tabulae, I am convinced that some other explanation would accord better with all the facts observed.

Tangential sections (Plate XIX, fig. 7) show scarcely any trace of the cut ends of pillars as such. The general appearance is that of a true *Stromatopora*. Very conspicuous are the large round openings which appear where the section follows the course of a lamina. The peculiar "astrorhizal tabulae" are very characteristic.

This form is most closely allied to *Stromatopora carteri*, Nich. It differs, however, in the cylindrical manner of growth.

the presence of astrorhizae and the character of the skeletal fibre. There is also a strong resemblance to *Idiostroma roemeri* which is shown in the vermiculate character of the surface, the cylindrical manner of growth and the general structure of the skeletal fibre. The presence of axial canals in the cylinders is extremely doubtful, they are certainly absent for the most part, but some evidence of their occasional occurrence is not wanting. The minute fibre appears to be dense; if this is really the case the form can be ascribed to neither *Stromatopora* nor *Idiostroma*, but it might be considered as an extreme example of the genus *Actinodictyon*. Such a determination is, however, carrying the interpretation of the "tabulae" as residual laminae beyond the point of absolute proof. This species is particularly interesting in that it shows a possible connection between *Clathrodictyon* and *Actinodictyon* on the one hand, and *Stromatopora* and *Idiostroma* on the other.

Locality.—Silurian, Southampton Island, Canada. Type specimen in the Museum of the Geol. Sur., Canada. Named after Dr. H. M. Ami, of the Geol. Sur., Canada.

Stromatopora carteri, *Nicholson.*—Plate XIX, Figs. 9 and 10.

Stromatopora carteri, Nich. Mon. Brit. Strom., p. 174, pl. i., figs. 6 and 7, pl. xxiii. figs. 1 and 3, 1891
Stromatopora carteri, Nich. Ann. and Mag. Nat. Hist., ser. 6, vol. vii, p. [illegible]4, pl. ix, figs. 5 and 6, 1891
Stromatopora [illegible] Ottawa Naturalist, vol. xxii, p. 48, 1908

Nicholson's description is as follows:—"The coenosteum in this species is of considerable size, massive, irregular in shape, and composed of gently undulating or curved latilaminae, which vary from 2 to 4 or 5 mm. in thickness in their central portion. The under surface and mode of attachment are not known, but the [illegible] surface is without distinct eminences or 'mamelons,' and shows simply an irregular vermiculate tuberculation. Astrorhizae are not developed in any recognized form.

"As regards internal structure, the skeletal fibre is about one sixth [illegible] diameter, and is coarsely porous. Vertical sections show that each latilamina is composed of very distinctly level [illegible] pillars, which are separated from one another by equally [illegible] zooidal tubes, and which really run con-

tinuously from the bottom to the top of each latilamina, though they appear to be more or less broken up, if the plane of section is slightly oblique. About seven radial pillars, with the intervening zooidal tubes, occupy a space of two mm. measured transversely. The zooidal tubes are furnished with a moderate number of well developed transverse partitions or 'tabulae.' The radial pillars are connected at varying intervals by irregular horizontal or oblique processes, but these do not give rise to distinct 'concentric laminae,' and the skeleton thus forms a loose and open reticulation, in which the vertical elements are far more conspicuous than the horizontal. As a result of this, tangential sections show the cut ends of the radial pillars, either as separate structures, or, more usually, as united by the irregular horizontal processes already spoken of in such a way as to give rise to vermiculate and sinuous rods, which inosculate with one another and form a lax network. A characteristic feature is the peculiarly loose and open nature of the reticulated coenosteal tissue. Another characteristic feature is the total or almost total absence of the branched and radiating astrorhizal canals, which are so conspicuous in most species of *Stromatopora*. In most examples of the present form no trace whatever of these structures can be found, and in none is there more than the merest indications of their existence. The surface, therefore, is simply smooth or gently undulated, and is entirely without 'mamelons.'

"*S. carteri*, as far as known, is entirely confined to the Wenlock limestone of Britain, and my specimens have been principally obtained from the single locality of Ironbridge, in Shropshire, where the species is not altogether uncommon, though vastly more rare than is *S. typica*, Rosen. The species has not hitherto been certainly recognized in the Silurian rocks of Gotland and Esthonia. Mr. Whiteaves has submitted to me for examination a fragment of a species of *Stromatopora*, obtained from a loose boulder on the banks of the Hayes River, Hudson Bay Territory, which very closely approaches in its characters to *S. carteri*, though my material is not sufficient to justify me in asserting that it is absolutely identical with the latter."

To this full description there is nothing to be added; a

small and ill preserved specimen from Hudson Bay approaches very closely to Nicholson's description and figures. The coarsely fibrous character of the tissue cannot be discerned, as the specimen is too much altered; in all other respects, however, it conforms very well except that the transverse section (Plate XIX, fig. 10) seems somewhat finer than the similar section figured by Nicholson. The resemblance of the vertical sections (Plate XIX, fig. 9) to Nicholson's (Mon. Brit. Strom., pl. xxxii, fig. 2) is perfect except for the lack of preservation in the minute fibre.

Locality.—Silurian, Station 641, W. J. Wilson, Pagwachuan River, Hudson Bay, Canada. Boulder on Hayes River, Hudson Bay, Canada.

STROMATOPORA WILSONI, *Parks.*—Plate XIX, Figs. 11 and 12.

STROMATOPORA WILSONI, *Parks*, Ottawa Naturalist, vol. xxii, p. 28, 1908.

As this species is known from a single fragment only, it is impossible to do more than infer the shape of the coenosteum. Judging from the curvature of the laminae it probably was of hemispherical shape and in all probability of considerable size. The coenosteum is made up of distinct latilaminae, about 8 mm. in thickness. Instead of being simply concentric the horizontal elements are folded upwards into low rounded monticules, about 15 mm. apart, so that the surface presents a [illegible]oidal appearance. This curvature of the laminae added to the very poor state of preservation makes it difficult to arrive at a clear understanding of the structure of the tissue. Distinct vertical pillars occur to the number of five or six in the space of one mm. It has not been observed that these pillars are continuous through the whole thickness of a latilamina. The vertical interspaces between the pillars are less in diameter than the pillars themselves. The horizontal laminae are likewise thick, and, though less pronounced than the pillars, they may be traced continuously for considerable distances. Astrorhizal systems are present and there is some indication that they are superimposed, giving rise to axial canals. The skeletal fibre, though now destroyed, was probably of an original fibrous character. The vertical section (Plate XIX, fig. 12) is so much restored that too much confidence must not be placed on it as a means of identifying this

species. The vertical elements are seen to be more pronounced than the horizontal; the change in direction of the laminae is exhibited and the conspicuous cut ends of the astrorhizal canals appear as round spaces.

Tangential sections (Plate XIX, fig. 11) are more satisfactory. The severed laminae appear as dense tissue pierced by the round openings representing the vertical pores. The branches of the astrorhizal systems appear as irregular openings; they are discontinuous because, owing to the curvature of the laminae, it is impossible to prepare a section which lies in any one interlaminar space.

While convinced that this species is distinct from any other, I must admit that the description is very inadequate; it is only the desire for completeness that induces me to describe the form at all. Better material will doubtless be obtained and result in modifications of the above description. That the form is distinct I believe for the following reasons: The fibre is much finer than that of *Stromatopora carteri* and *S. amii* on the one hand, and coarser than that of *S. constellata* on the other. The astrorhizal systems are more distinct than in *S. carteri*, and the horizontal laminae are better developed than in that species. While I do not consider the botryoidal manner of growth as of specific value, I have never observed it in specimens of *S. constellata*, and I have never prepared tangential sections of that species in which distinct, connected astrorhizal canals did not appear. The species differs from *S. constellata* also in the more irregular course of the pillars and the occasional very large openings of the astrorhizal canals as seen in vertical section. However, with a single, very poorly preserved specimen as type, the species must be regarded as resting on an insecure foundation.

Locality.—Silurian, Pagwachuan River (near mouth) Hudson Bay, Canada. Type specimen in Museum of Geol. Sur., Canada.

STROMATOPORA CONSTELLATA, *Hall*

For synonomy and description, see *Niagara Stromatoporoids*, page 44.

This form (*S. hudsonica*, Dawson,) is common in the Silurian area west of Hudson Bay, but there is no example in the large collection from Southampton and Beechy Islands.

III. ADDITIONAL NIAGARA STROMATOPOROIDS

ACTINOSTROMA TENUISSIMUM, *sp. nov.*—Plate XVIII, Figs. 2, 3, 9 and 12.

With regard to the general shape of the coenosteum there is little to be said, as the only specimen is intercalated between two different species of *Stromatopora*: it appears, however, to have had an incrusting habit with a tendency to form a hemispherical mass.

The organism is made up of extremely fine vertical fibres, about 24 of which appear in the space of one mm., and delicate connecting arms, arising in whorls after the manner of a typical *Actinostroma*. The horizontal "laminae" formed by these arms are not nearly as regular and persistent as the vertical elements. The interspaces between the fibres are much larger than the fibres themselves, so that the general appearance of sections is that of a delicate open network. The coenosteum is interrupted at intervals of about 2 mm. by horizontal (concentric) partings, giving to the skeleton a pronounced latilaminar structure. Certain large open canals or interspaces traverse the general tissue, but these are so far apart and so irregular that I am of the opinion that they are quite foreign to the organism.

Vertical sections which follow the course of the pillars (Plate XVIII, fig. 3) are very hard to prepare owing to the extreme tenuity of these elements. However, the examination of an extended section leaves no doubt as to the practical continuity of the fibres through a latilamina. The horizontal laminae are less continuous but may be distinctly seen in certain parts of a section.

Tangential sections (Plate XVIII, fig. 2) show the cut ends of the pillars with connecting arms of about the same diameter, so that the general appearance is that of a "hexactinellid" network.

To exhibit the gross anatomy photographs rather than drawings have been inserted in order to eliminate any possible

"personal equation," as this species must be considered of the utmost importance in discussing the affinities of the Stromatoporoids. The drawings of vertical and tangential sections on a scale of magnification of 30 were prepared, as were the other figures on the same scale, on the photographic print, from which the silver was afterwards removed. Plate XVIII, fig. 12, shows that the fibre differs from that of an ordinary *Actinostroma* only in its extreme tenuity. The tangential section (Plate XVIII, fig. 9), except for a little sharper definition of the radial pillars, is precisely like that of *Stromatopora constellata*.

In its general anatomy this species is certainly very closely related to *Actinostroma astroites*, Rosen. It is, however, much finer, as in that species only from 12 to 15 fibres appear in the space of one mm. The resemblance of the two species is also seen in the lack of continuity in the horizontal laminae and in the pronounced latilaminar subdivisions. The presence of astrorhizae has not been established, but, lacking a surface, and considering the extreme delicacy of the fibre, it is impossible to say that they do not exist.

Nicholson has commented on the resemblance of *Actinostroma astroites* to *Stromatopora typica*, but he has dismissed the comparison on the ground that the resemblance is due merely to the alteration of the latter species. Whatever justification there may be for his view, I am convinced that in *Actinostroma tenuissimum* and in *Stromatopora constellata* we have two organisms of exactly the same ultimate skeletal fibre, differing only in the fact that the latter species is pierced by a series of vertical and a series of horizontal canals. Further, it is very significant that the two species should be found growing together, conforming to the same curvature, and separated by no greater an interval than that which divides the latilaminae of the former species. It is further significant that the Helderbergian species of *Stromatopora* and of *Syringostroma* herein described present the same ultimate structure. The conclusion seems obvious that the vertical and horizontal canals are not essential to the life of the organisms as a *class*. As long as these canals are interpreted as *pores*, their presence or absence may not necessarily be vital, but if the vertical passages are considered as the habitations of

zooids, those zooids are an essential part of the organism, and it is difficult to explain how life could be maintained without them.

The species must be considered as an *Actinostroma*, despite its extreme delicacy and its intimate relation to *Stromatopora*. Should the conclusions given above be more fully established, a complete revision of the classification of Stromatoporoids will be required.

Locality.—Niagara limestone, Scoharie County, New York. The type and only specimen is in the Museum of the State of New York, Albany, N.Y.

Genus—AULOCERIUM, *gen. nov.**

Nicholson has made the genus *Labechia* include those forms originally described as *Stromatocerium*, so that species of which the coenosteum consists essentially of a series of vesicles pierced by pillars must be ascribed to *Labechia*. The genus about to be described is precisely like *Stromatocerium*, or *Labechia*, in the fact that the skeleton is composed of rows of vesicles, with the convexities directed outwards. It differs, however, in that there are no pillars whatever. Instead of possessing these radial structures the coenosteum is pierced by distinct tabulate tubes of large size. These tubes resemble the "Caunopora tubes" presented by many species, but whether they are essential to the organism or whether they may be absent in some examples of the same species it is impossible to say, as only one fragment is available. In this fragment the tubes are an integral part of the coenosteum. The one species here included cannot be placed under *Labechia*, as there are no radial pillars. It cannot be called *Stromatocerium*, as Nicholson has abandoned that genus, and it does not seem advisable to revive it.

AULOCERIUM SAVAGEI, *sp. nov.*—Plate XVIII, Figs. 13 and 15

The coenosteum is known from a small fragment about 30 mm. sq., with a thickness of 20 mm. The general form was probably laminar, and the organism probably attained consider-

* αὐλός, tube; κηρίον, honeycomb.—For this generic name I am indebted to Professor W. S. Milner, of the University of Toronto.

able dimensions. The skeletal matter consists of rows of vesicles, with the convexities outwards, about six vesicles appearing in the space of 1 mm., measured vertically. The maximum extent of a vesicle horizontally is something over ½ mm. The cavities appear to have been hollow, and their walls are very delicate. At a fairly uniform interval of 2 mm. large tubes of about ⅓ mm. diameter pierce vertically through the vesicular tissue. The walls of the tubes are thin—of about the same calibre as the fibre of the vesicles. The tubes are crossed by four or five tabulae in the distance of 1 mm. These tabulae are strongly curved downwards, and are likewise of about the same weight as the walls of the vesicles. I am of the opinion that these tubes are not foreign to the organism, for the following reasons. They arise suddenly, of full diameter, at various levels in the coenosteum. They are of the same diameter as a vesicle. They are evenly spaced. Their substance is of the same microscopic appearance as the rest of the coenosteum. They are intimately united, even blended, with the vesicular tissue.

Vertical sections (Plate XVIII, fig. 13) exhibit the general features described above

Tangential sections (Plate XVIII, fig. 15) show the severed vesicular walls and the cross-sections of the tubes. The inner circle to be observed in some of the tubes represents the cut edges of the depressed tabulae. The vesicles are not equal in size, and bands of smaller cells appear at certain intervals. The severed edges of the vesicles of such a zone appear in the upper right-hand part of the figure. It is possible that these small meshes mean that the tissue of the vesicular walls is not continuous, but reticulate No trace of discontinuity is, however, shown in vertical section

This species, the only representative of the genus, is very interesting, in that it may throw some light on the origin and significance of the pillars in *Labechia*. Here we have open, tabulate tubes taking the place of, and doubtless performing the same function as, the pillars of *Labechia*. If these tubes represent the habitation cavities of zooids, it is a fair assumption that the pillars of *Labechia* are of the same nature.

Locality.—Niagara limestone, within five feet of the base,

Wilmington, Ill. Part of the type is No. 1267N, University of Toronto Museum; the other part is in the possession of Mr. T. E. Savage, Geological Survey, Illinois, Urbana, Ill. The species is named for Mr. Savage, who collected the material and through whose kindness the opportunity of description was afforded

STROMATOPORA CONSTELLATA, *Hall.*—Plate XVII, Figs. 10 and 11; Plate XVIII, Fig. 8

For synonomy and description, see *Niagara Stromatoporoids*, page 44

The examination of a number of excellently preserved examples of this species and the comparison of them with the similar species from the Helderbergian has led me to materially alter the opinion previously expressed as to the interpretation of the structures observed. Without the information now at hand there was no reason to doubt Nicholson's conclusion that the vertical pores represent the habitation cavities of zooids. I am now inclined to believe that this opinion is erroneous

Growing beneath a colony of *S. constellata* I have found an exceedingly fine-grained Stromatoporoid having the typical structure of [illegible] *Actinostroma.* The vertical elements in this species are a[illegible] [illegible] mm. apart; the horizontal laminae are less pronounced, but, with the vertical threads, build up a reticular network, which differs from *Actinostroma* only in its extreme tenuity. The ultimate fibre of the overlying *S. constellata* has exactly the same structure. Further, this same reticular fibre is exhibited by *Syringostroma ristigouchense, S. centrotum, S. consimile, Stromatopora foveolata,* and other Helderbergian species. It seems an obvious conclusion that all these species represent similar fine reticulations traversed by systems of vertical and horizontal pores. The existence of the fine tissue without pores, especially vertical pores, proves that zooids are not essential to the life of the organism. This is at least good negative evidence that the vertical pores of *S. constellata* are not zooidal in character. In the various Helderbergian species named above the horizontal laminae may consist of a single layer of fibres or of several. The laminae are separated by the ramifications of the astrorhizal canals, which leave certain vertical

supports of the original tissue between the laminae. If these supports are superimposed and circular, we have the genus *Syringostroma;* if they are not circular, whether superimposed or not, we have a true *Stromatopora*. *S. constellata* belongs exactly here. It consists of a fine Actinostroma-like reticulation, with alternate layers of non-areolated tissue (the laminae) and of open fenestrated and canal-traversed tissue (the interlaminar spaces). There is absolutely no difference, in character or origin, between the tissue of the laminae and that of the pillars. The interlaminar passages are placed in communication with one another vertically, to a greater or less extent, by finer pores passing through the laminae (the so-called zooidal pores). In the first place, if these pores are zooidal in character, why do they always communicate with the astrorhizal canals? This communication is seen to perfection in vertical sections of *Stromatopora foveolata* (Plate XVII, figs. 5 and 6). In most figures of *Stromatopora* the connection between vertical and horizontal tubes is complete—so complete that it is impossible to state where the one ends and the other begins. In my own figures of *S. constellata* (*Niagara Strom.*, Plate XIII, figs. 7 and 8), if we interpret the vertical pores as zooidal, what has become of the astrorhizal canals? It is absolutely necessary to restrict the imaginary zooid to a single lamina. This leads to an absurdity: Some laminae are only of the thickness of a single fibre, therefore the zooid could have a vertical extent of about $\frac{1}{10}$ mm. In *S. constellata* the laminae are comparatively thick, and the pores are seen to be crossed by "tabulae." This circumstance is used by Nicholson as the strongest argument as to the zooidal character of the tubules. *These so-called tabulae are merely fibres of the general reticulation passing across the pore.* If, with Nicholson, we consider the pores to be continuous through several laminae, each "tabula" is generally coincident with a lamina. Sometimes this is not the case, and a "tabula" crosses in an interlaminar space. The explanation is the same. In Plate XVII, fig. 10, occasional fibres are seen to cross the open spaces between the gross vertical elements in the parts of the section which are evidently interlaminar. Such a fibre, seen in vertical section, could be easily mistaken for a "tabula."

It would be premature to state that no zooidal tubes occur in any Stromatoporoids, but I am convinced that there is no direct evidence of their existence in any species of the genus *Syringostroma* and that the vertical pores of *S. constellata* and its allies from the Helderbergian are not to be interpreted as such.

Both tangential and vertical sections (Plate XVII, figs. 10 and 11) show that *S. constellata* is closely allied to *Syringostroma*. The columns in the interlaminar spaces are sometimes quite round, but the laminae are much too thick and separated by too slight an interval to allow of its reception in that genus.

A tangential section, magnified thirty times, is introduced in order to make a comparison with the other species possible. (Plate XVIII, fig. 8.)

Locality.—Niagaran. The distribution of this species has been given in *Niagara Stromatoporoids.* The figures here produced were prepared from sections No. 851 and No. 853, New York State Museum, Albany, N.Y.

STROMATOPORA CLARKEI, *sp. nov.*—Plate XVII, Fig. 12; Plate XVIII, Fig. 1.

This species is known from one small specimen only, and this is so intergrown with other species that no information as to the general shape of the coenosteum is available.

The horizontal and vertical elements are poorly defined, so that the structure of a typical *Stromatopora* is presented. Division of the coenosteum into latilaminae is not strongly marked, but is apparent. The ultimate fibre is porous, but a rectangular arrangement of the constituent threads has not been observed. The tissue is pierced by large vertical passages and is traversed horizontally by anastomosing astrorhizal canals.

Vertical sections (Plate XVII, fig. 12) show from four to five vertical pseudo-pillars in the space of one mm. These pillars are not strictly parallel and the vertical passages between them may, in some cases, be quite flexuous. Some of these passages are continuous across a latilamina—a distance of from $1\frac{1}{2}$ to 2 mm. Owing to the small size of the specimen, it was impossible to prepare many sections, so that a more regular

appearance than that presented by the figure might be obtained from better oriented sections.

Horizontal elements are very slightly shown but appear as thin lines crossing the vertical passages. These structures may be interpreted as tabulae, but I have great doubt as to the correctness of this view, and for the following reasons. The lines are continuous across several vertical passages, at least in many instances. Similar lines are seen to run horizontally through the horizontal canals. The lines are seen to [illegible] maintain their identity in crossing the pillars.

Tangential sections (Plate XXIII, fig. [illegible]) present a very characteristic appearance. The horizontal canals of the astrorhizal system lose little in diameter as they depart from the centre, and as they have about the same calibre as the vertical passages and are confluent with them a uniform open reticulation results. The even character of the section is further increased by the slight development of horizontal laminae so that no conspicuous darker patches, pierced by pores, are observable, as is the case in most examples of the genus.

The species is easily distinguished from *S. constellatum* by its coarser character, its less pronounced laminae, and the characteristic arrangement of its astrorhizal canals.

Locality.—Niagara limestone, Schoharie County, New York. The type and only specimen is in the Museum of the State of New York, Albany, N.Y.

EXPLANATION OF PLATES XVI TO XX

(All figures not otherwise specified are enlarged ten times)

PLATE XVI

Fig. 1—*Clathrodictyon jewetti* Vertical section. Cedarville, N.Y.
Fig. 2— " " Tangential section. Cedarville, N.Y.
Figs 3 and 4—*Syringostroma ristigouchense.* Vertical section. Cap Bon Ami.
Fig. 5— " " Tangential section. Cap Bon Ami.
Fig. 6—*Syringostroma centrotum.* Vertical section. Cedarville, N.Y. From N. Y. State Museum, slide no. 1757
Fig. 7— " " Vertical section. Cedarville, N.Y. From N. Y. State Museum, slide no. 1757
Fig. 8— " " Tangential section. Cedarville, N.Y. From N. Y. State Museum, slide no. 1756.
Fig 9— " " Tangential section. Cedarville, N.Y. From N. Y. State Museum, slide no. 1756
Fig 10—*Syringostroma consimile.* Vertical section. Outlet of Skaneateles lake, N.Y. From type in Yale Museum.
Fig. 11— " " Tangential section. Outlet of Skaneateles lake, N.Y. From type in Yale Museum.
Fig. 12— " " Vertical section. Scoharie county, N.Y. From U.S.N.M., no. 36845

PLATE XVII

Fig 1—*Syringostroma barretti.* Tangential section. Clarksville, N.Y. From N. Y. State Museum, slide no. 735
Fig 2— " " Vertical section. Clarksville, N.Y. From N. Y. State Museum, slide no. 736.
Fig 3—*Syringostroma microporum.* Tangential section. Cedarville, N.Y. From type slide in Yale Museum
Fig 4— " " Vertical section. Cedarville, N.Y. From type slide in Yale Museum. The right of the figure is restored
Fig 5—*Stromatopora foveolata.* Vertical section. Cedarville, N.Y. From N. Y. State Museum, slide no. 1736.
Fig 6— " " Vertical section. Cedarville, N.Y. From N. Y. State Museum, slide no. 1736.
Fig 7— " " Tangential section. Cedarville, N.Y. From N. Y. State Museum, slide no. 1733.
Fig 8—*Stromatopora coralliferа.* Vertical section. Port Jervis, N.Y. From Am. Mus. Nat. Hist., no. 2270—3
Fig 9— " " Tangential section. Port Jervis, N.Y. From Am. Mus. Nat. Hist., no. 2270—3
Fig 10—*Stromatopora constellata* Tangential section. Scoharie county, N.Y. From N. Y. S. Museum, slide no. 851

Fig 11.—*Stromatopora constellata.*—Vertical section. Scoharie county, N.Y From N. Y S. Museum, slide no 852

Fig. 12—*Stromatopora clarkei.* Vertical section. Scoharie county, N.Y From N. Y. State Museum specimen.

PLATE XVIII

Fig. 1—*Stromatopora clarkei.* Tangential section. Scoharie county, N.Y. From N. Y. State Museum specimen.

Fig. 2—*Actinostroma tenuissimum.* Tangential section. Scoharie county, N.Y. From N. Y. State Museum specimen

Fig 3— " " Vertical section Scoharie county, N.Y. From N. Y State Museum specimen.

Fig. 4—*Stromatopora foveolata.* Tangential section x 30 As above

Fig 5—*Syringostroma barretti.* Tangential section x 30. As above.

Fig. 6—*Syringostroma centrotum.* Tangential section x 30. As above.

Fig. 7—*Stromatopora corallifera.* Tangential section x 30 As above

Fig. 8—*Stromatopora constellata.* Tangential section x 30 As above.

Fig. 9—*Actinostroma tenuissimum.* Tangential section x 30. As above.

Fig 10—*Stromatopora foveolata.* Vertical section x 30. As above

Fig. 11—*Syringostroma centrotum* Vertical section x 30. As above

Fig. 12—*Actinostroma tenuissimum.* Vertical section x 30 As above

Fig 13—*Aulocerium savagei.* Vertical section. Wilmington, Ill From Geol Sur. Ill. specimen.

Fig 14—*Syringostroma consimile.* Tangential section x 30. As above.

Fig 15—*Aulocerium savagei.* Tangential section. Wilmington, Ill. Geol Sur. Ill. specimen.

PLATE XIX

Fig 1—*Actinostroma tenuifilatum inflectum.* Vertical section. Pagwachuan river, Canada Geol. Sur. Can. specimen.

Fig 2— " " " Tangential section. Pagwachuan river, Canada Geol. Sur. Can specimen.

Fig 3—*Actinostroma franklinense.* Vertical section. Beechy island, Lancaster sound, Canada. Geol. Sur. Can. specimen.

Fig 4— " " Tangential section. Beechy island, Lancaster sound, Canada. Geol. Sur Can specimen.

Fig 5—*Actinodictyon keelei.* Tangential section. Gravel river, Mackenzie river, Canada Geol Sur. Can specimen.

Fig 6— " " Vertical (longitudinal) section Gravel river, Mackenzie river, Canada Geol. Sur Can specimen

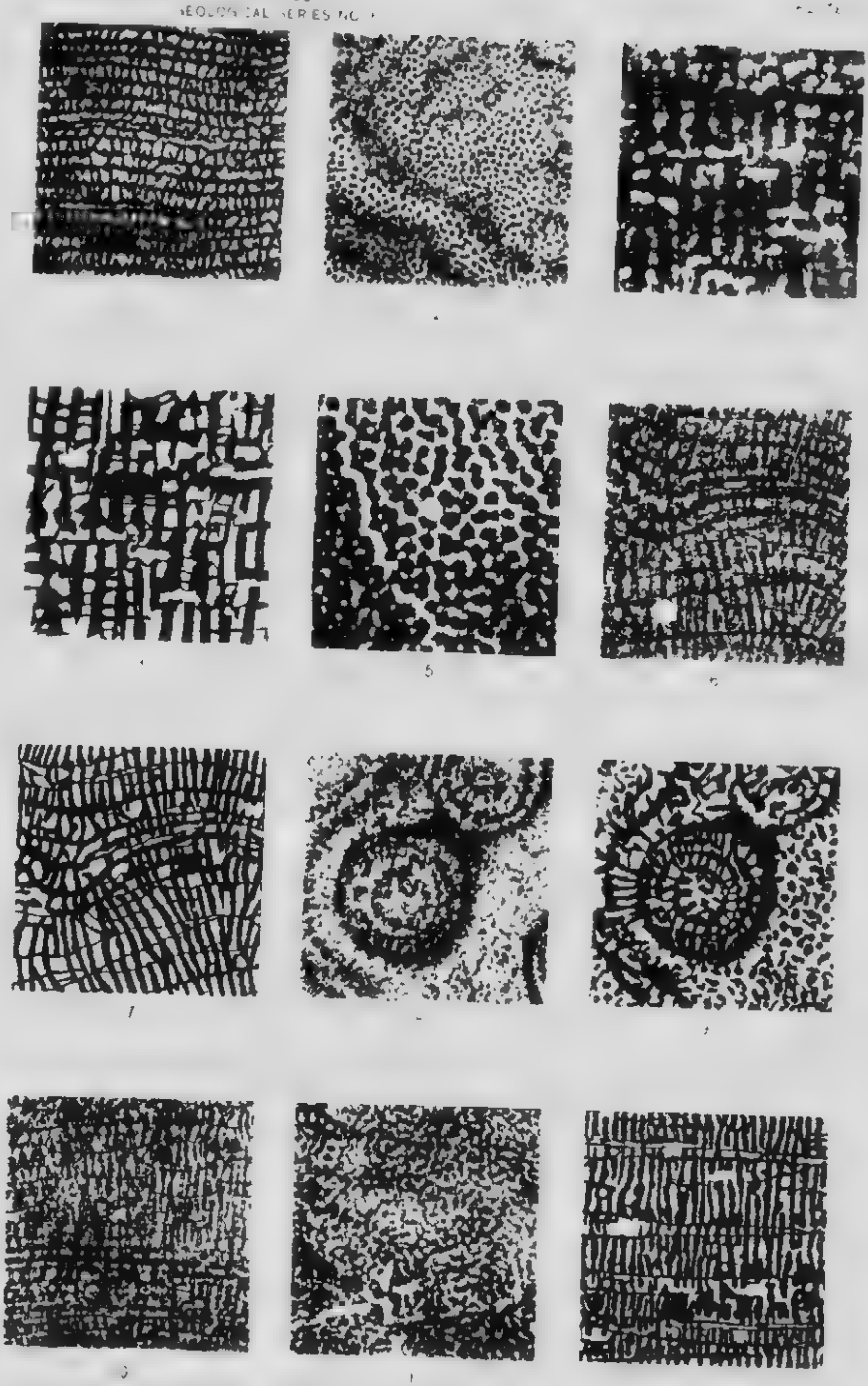
Fig 7—*Stromatopora amii* Tangential section. Southampton island, Hudson bay. Geol. Sur Can, slide no. 2234.

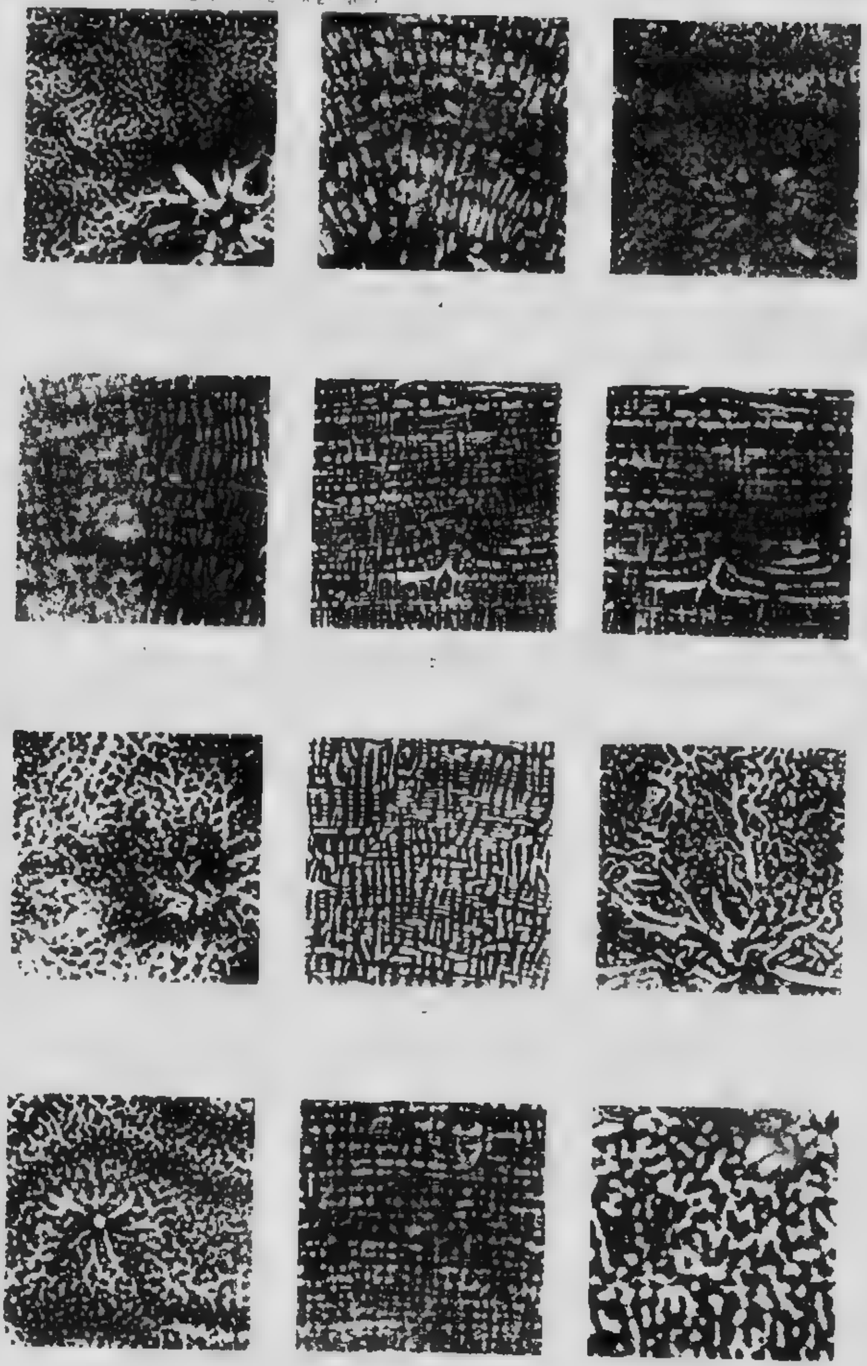
Fig 8— " " Vertical section. Southampton island, Hudson bay. Geol Sur. Can, slide no 2235

Fig. 9—*Stromatopora carteri.* Vertical section. Pagwachuan river, Hudson bay, Canada. Geol. Sur. Can. specimen.
Fig. 10— " " Tangential section. Pagwachuan river, Hudson bay, Canada. Geol. Sur. Can. specimen.
Fig. 11—*Stromatopora wilsoni.* Tangential section. Pagwachuan river, Hudson bay, Canada. Geol. Sur. Can. specimen.
Fig. 12— " " Vertical section Pagwachuan river, Hudson bay, Canada. Geol. Sur. Can. specimen.

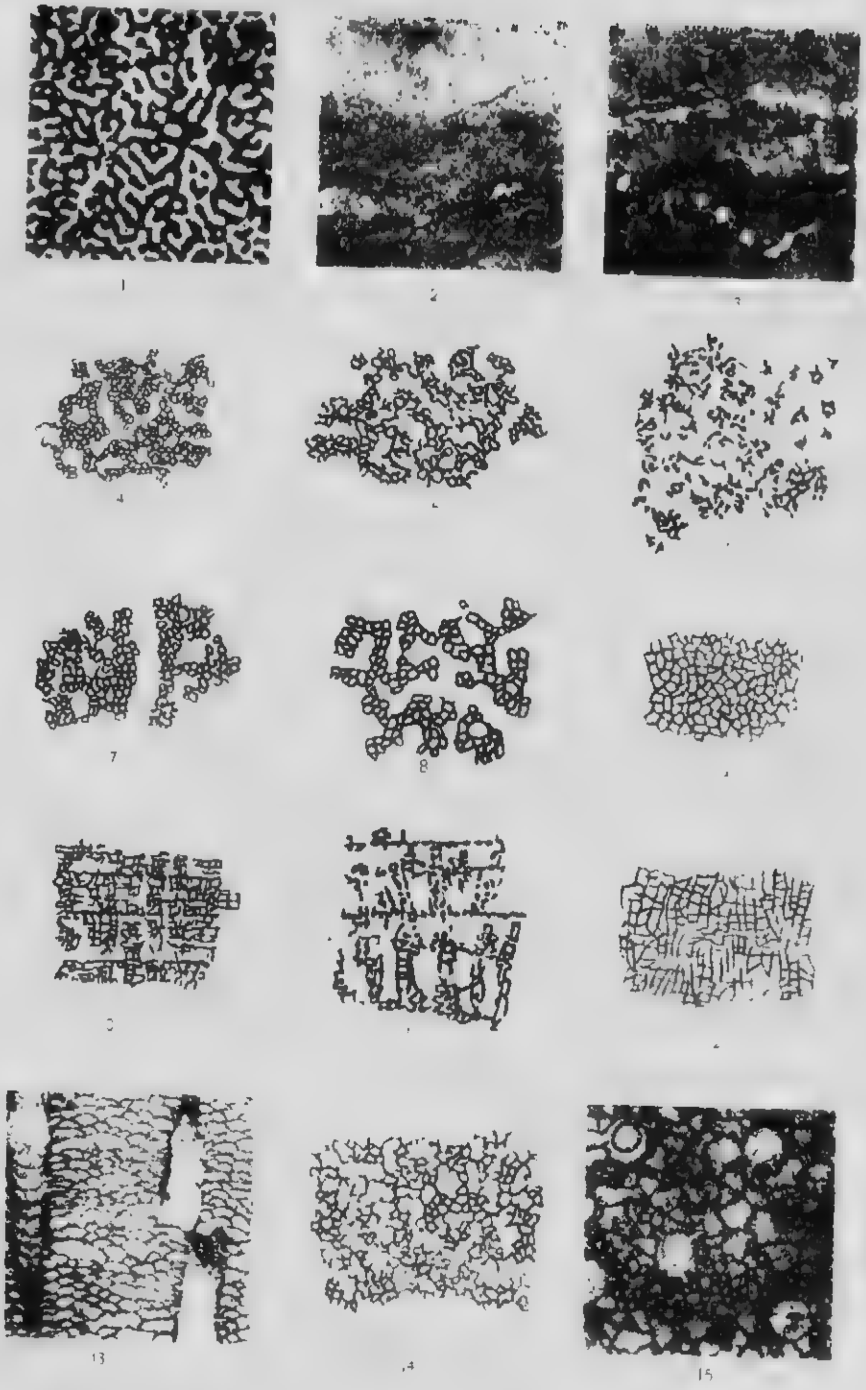
PLATE XX

Fig. 1—*Actinodictyon canadense.* Vertical section. Southampton island, Hudson bay. Geol. Sur. Can specimen.
Fig. 2— " " Tangential section. Southampton island, Hudson bay. Geol. Sur. Can specimen.
Fig. 3—*Actinodictyon lowi.* Vertical section. Southampton island, Hudson bay. Geol. Sur. Can. specimen.
Fig 4— " " Tangential section. Southampton island, Hudson bay. Geol. Sur. Can., slide no. 2271.
Fig. 5—*Actinodictyon neptuni.* Vertical section. Southampton island, Hudson bay. Geol. Sur. Can. specimen.
Fig. 6— " " Tangential section. Southampton island, Hudson bay. Geol. Sur. Can. specimen.
Fig. 7—*Clathrodictyon drummondense.* Vertical section. Southampton island, Hudson bay. Geol. Sur. Can. specimen.
Fig. 8— " " Vertical section. Southampton island, Hudson bay. Geol. Sur. Can. specimen.
Fig. 9—*Clathrodictyon cystosum lineatum.* Beechy island, Lancaster sound. Geol. Sur. Can. specimen.



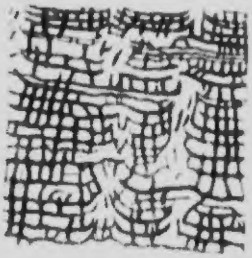


W. A. PARKS [illegible]

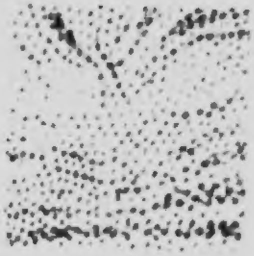


W. A. PARKS, PHOTO MIC. AND DEL.

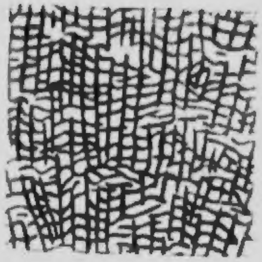
[illegible]



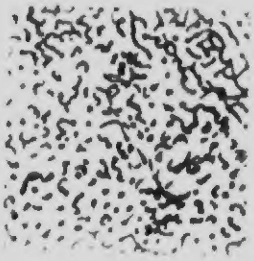
1



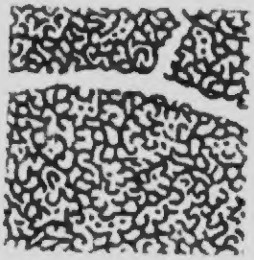
2



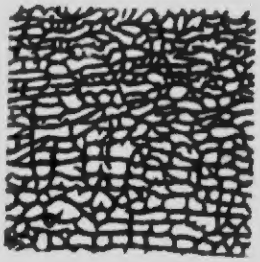
3



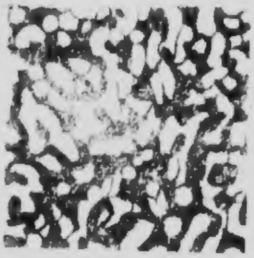
4



5



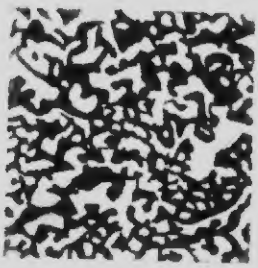
6



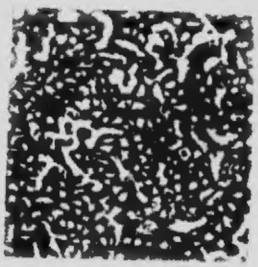
7

8

9



10

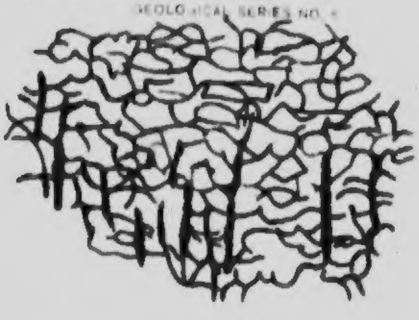


11

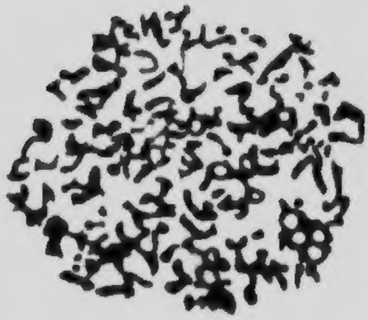
12

W. A. PARKS, DEL.

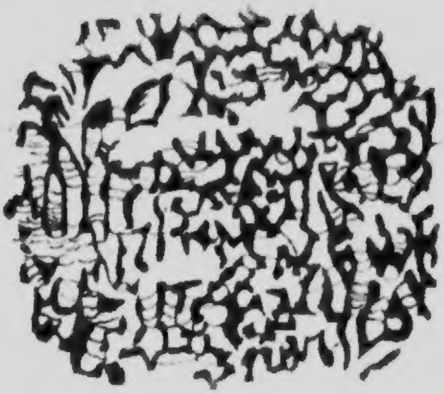
COCHRANE, BOSTON



1

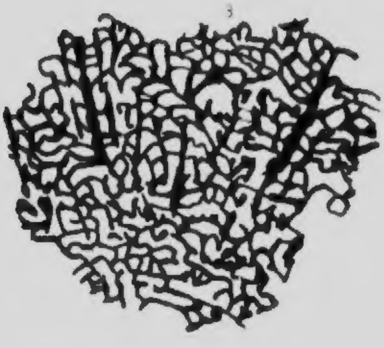


2

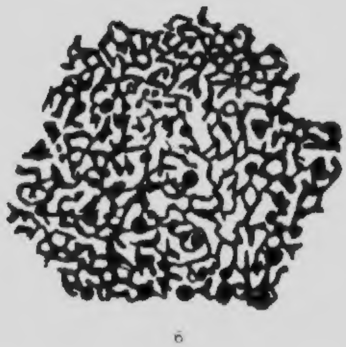


3

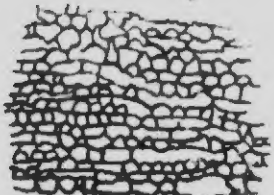
4



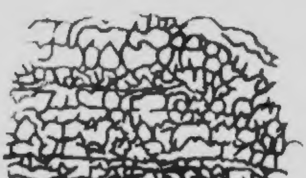
5



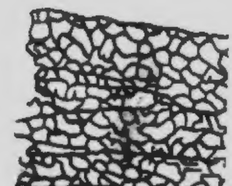
6



7



8



9

W. A. PARKS DEL.

COCKAYNE, BOSTON